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GEOLOGY

NNSYLVANIA

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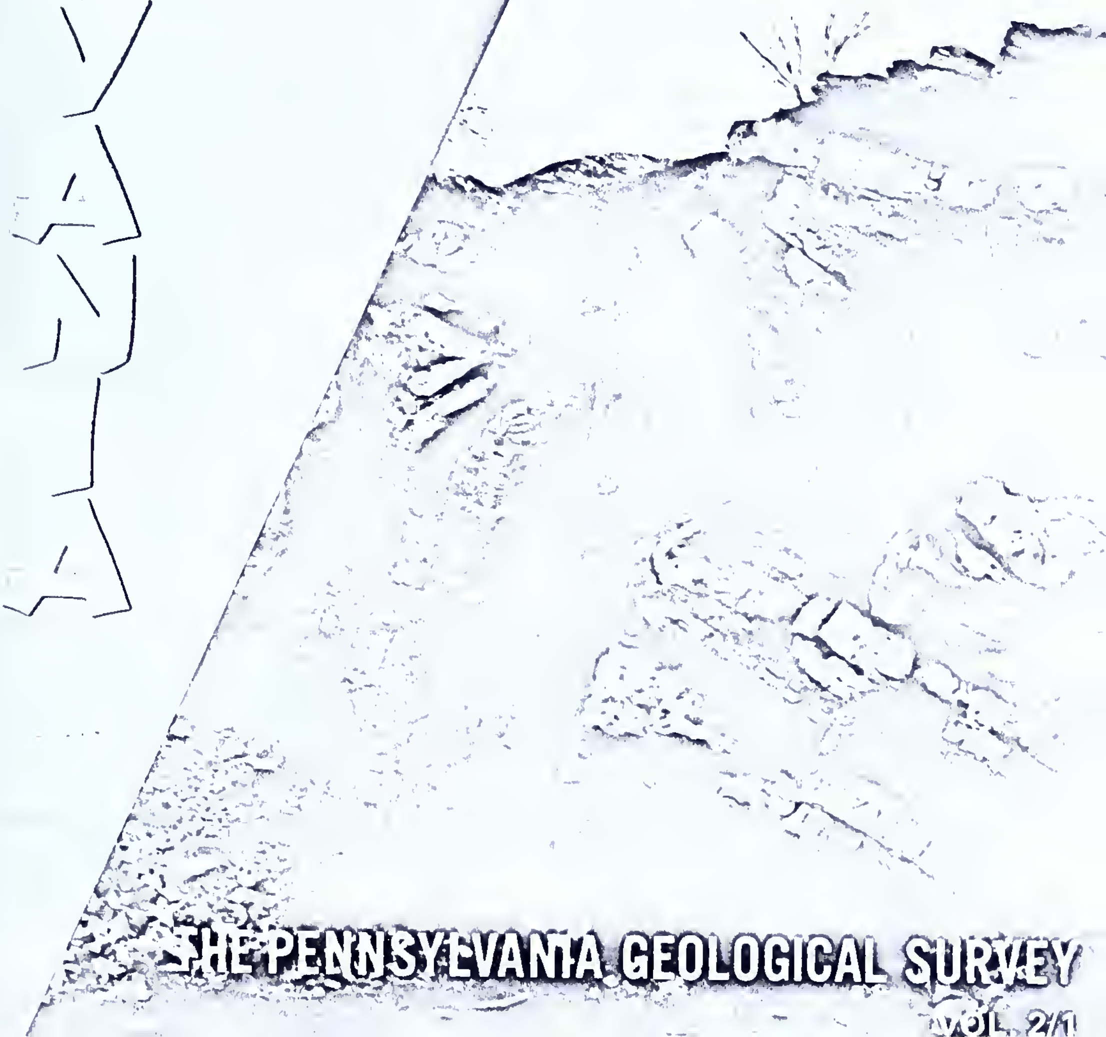

THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 2/1

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER – Intricate folding and faulting of limestones and dolomites of the Epler Formation near Annville, Lebanon County, Pennsylvania.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

FEBRUARY 1971

FROM THE DESK OF THE STATE GEOLOGIST . . .

THE PENNSYLVANIA SURVEY JOINS NEW DEPARTMENT

January 19, 1971, was a momentous day in the 135-year history of the Pennsylvania Geological Survey. On that day the Bureau of Topographic and Geologic Survey, by an Act of the Legislature, was transferred to the newly created Department of Environmental Resources. This is the fourth department to which the Survey has been attached in the past 50 years, the previous ones being Forests and Waters, Internal Affairs, and State Planning Board. Each of the past agencies offered most pleasant working relationships for the Survey. Over the years with those agencies the Survey has been able to accept the broadened scope of geologic and environmental responsibilities and services with which it has been called upon to cope.

The Survey's association with the State Planning Board during the past two years has been particularly mutually beneficial. The Survey has come to recognize in great detail the urgent need for input of geologic expertise and data into the planning process. The Planning Board, in turn, has recognized more fully the ability of geology to aid in making critical evaluations for planning and land use studies. The Survey is most appreciative of its pleasant relationship with the State Planning Board.

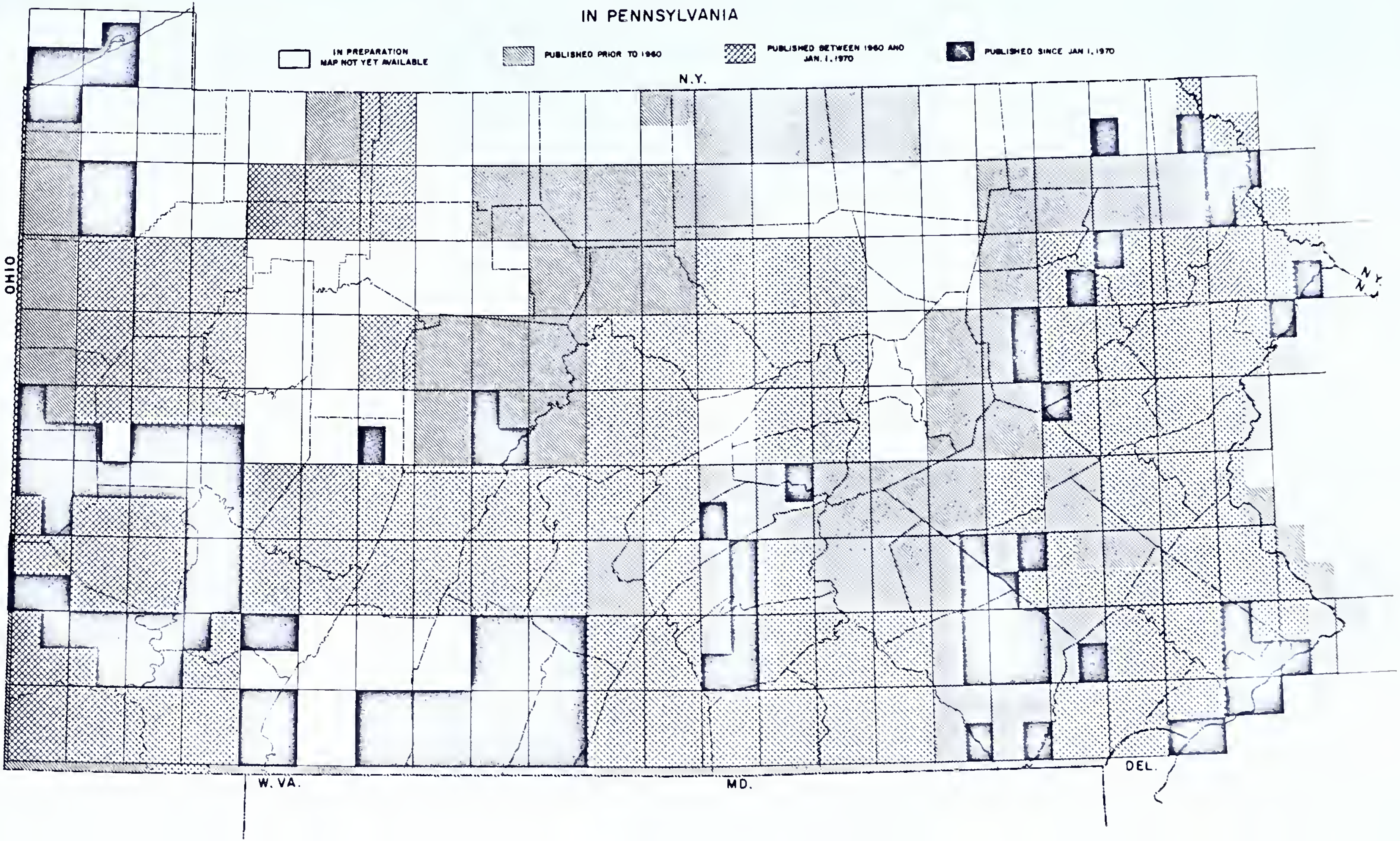
As has been noted in this column in past issues, geology is by definition an environmental science, and geologists continually work with phenomena and problems of the environment. Thus, it was not surprising that as plans developed for the creation of a new Department of Environmental Resources, the Survey was early considered to be a necessary, integral part of such a new department.

In the Department of Environmental Resources, we shall be joining with agencies and friends with whom we have long worked together and shared common interests. These include the former Department of Forests and Waters, the former Department of Mines and Mineral Industries, from the Health Department the Bureau of Sanitary Engineering, Housing and Environmental Control, Air Pollution Control, and Radiological Protection, and from Agriculture, the State Soil and Water Conservation Commission. We welcome the new relationship with these important and distinguished agencies.

The Topographic and Geologic Survey will undoubtedly be called upon more than ever to furnish data, services, and expertise in a coordinated effort to maintain the quality of Pennsylvania's natural environment. We look forward to this exciting challenge.

Arthur A. Socolow

STATUS OF 7½ MINUTE (1"=2000') TOPOGRAPHIC MAPPING IN PENNSYLVANIA



TOPOGRAPHIC MAPPING IN PENNA.

The topographic mapping program in Pennsylvania is being conducted cooperately by the Pennsylvania Geological Survey and the United States Geological Survey.

The adjoining map shows the progress to date in preparation of up-to-date 7.5 minute quadrangle (1 inch = 2,000 feet) topographic maps for Pennsylvania.

A detailed index to these maps is available free from:

Pennsylvania Geological Survey
Main Capitol Annex
Harrisburg, Pa. 17120

Washington Distribution Section
U. S. Geological Survey
1200 South Eads Street
Arlington, Va. 22202

Topographic maps may be purchased for $0.50 each from the Washington Distribution Section as listed above. On such orders, customers should state the name of the map as well as the type of map desired and are urged to use order blanks supplied with the Index to Topographic Mapping in Pennsylvania mentioned above. Orders must be accompanied by cash, check, or money order in the exact amount. Stamps will not be accepted as payment.

At slightly higher costs, maps may be purchased across the counter at the agents in Pennsylvania listed below:

- ALLENTOWN
  - Nestor Sporting Goods, Inc.
- BETHLEHEM
  - H. M. Paul & Son
- BRADFORD
  - Francis J. Talerico
- BROOKVILLE
  - DeMans
- CROSS FORK
  - Anderson's Esso Service
- DOYLESTOWN
  - Alfred B. Patton, Inc.
- ERIE
  - Commercial Blue Print & Supply Co.
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  - J. W. Fisher & Son
- HAWLEY
  - J. Vance Hunt & Son
- HAZLETON
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- INDIANA
  - Henry Hall, Inc.
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- JOHNSTOWN
  - Turner's Key Shop
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  - Aurand's
- MEADVILLE
  - Hunters News
- MILFORD
  - Sportsmen's Rendezvous
- MILLHEIM
  - John W. Cooner
- MORRIS
  - Miller's Store

(continued on page 4)

- PAOLI
  - Bookmark
- PHILADELPHIA
  - J. L. Smith Co.
- PITTSBURGH
  - Pen-Oh-Wes Map Co.
  - J. R. Weldin Company
- READING
  - Moyer's Stationery, Inc.
- SAINT MARYS
  - Smith's Sport Store
- SCRANTON
  - Deemer & Co.
- STROUDSBURG
  - Monroe Engineering, Inc.
- WATERVILLE
  - Love's Service Station
- WELLSBORO
  - Linck Sporting Goods
- WILKES-BARRE
  - Deemer & Co.
- WILLIAMSPORT
  - Plankenhorn Stationery Co.
  - Yoas Plate Service

NEW ATTENTION TO ROCK STABILITY

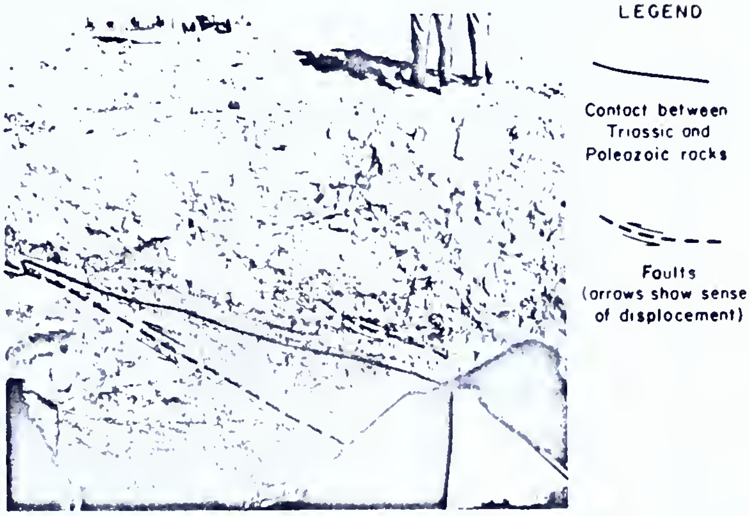
Construction stability in the Pittsburgh region has been a subject of increasing environmental concern, particularly evident in post-mortem attention to failures. Recently this concern has become more appropriately focused on pre-construction feasibility and planning as witnessed by the widespread newspaper, radio, and television publicity given to the proposed East Street Valley expressway north out of the city. The result of this attention has been, and will be, beneficial to all. Greater consideration is being given to the significant geological factors that play such a large role in the serious landslide and rockfalls of the region. Progress in the Pennsylvania Geological Survey compilation of geological data relevant to these hazards (reported in Volume 1/7), and the impending major U.S.G.S. – Pennsylvania Geological Survey environmental study of the Pittsburgh region will afford and make readily available to all concerned the required geological data necessary in the knowledgeable forewarning and prevention of these types of construction failures in the area. The continuing policy of Pennsylvania Geological Survey cooperation with all interested groups has effected greatly improved knowledge as to the nature of these hazards and the necessity for incorporation of geological data.

Dana R. Kelley

GEM AND EARTH SCIENCE SHOW

The Mineralogical Society of Pennsylvania will present its 10th Biennial EARTH SCIENCE AND GEM SHOW on April 17-18, 1971, at Thomas Hall, Valley Forge Military Academy, Wayne, Pennsylvania. More specific information may be had by writing Mr. Lawrence Heinrich, 1057 Eagle Road, Wayne, Pa. 19087.

230 MILLION YEARS OF ROCK MISSING


LEGEND
Contact between Triassic and Paleozoic rocks
Faults (arrows show sense of displacement)

The line drawn on the adjacent photograph represents a 230 million year gap between the rocks below and those above. The shales and limestones below are at least 430 million years old, and the Triassic rocks above are about 200 million years old. A gap in the geological record such as this is not common and good exposures are even rarer.

This exposure was uncovered during the construction of an overpass on new U.S. 230 near the Highspire entrance to the Pennsylvania Turnpike, east of Harrisburg. Before the rocks were covered up again, geologists from the Pennsylvania Geological Survey examined the area, took photographs, and collected samples for laboratory study. This contact between younger Triassic rocks and older Paleozoic rocks has been a subject of controversy among geologists for more than 100 years because it is seldom seen even though it extends from west of Gettysburg to the Delaware River and on into New Jersey.

Several explanations have been offered to explain the nature of this contact and the absence of 230 million years of rock. One of these is that the contact is a steep fault that moved rocks downward on the south (right) side during Triassic time. According to this theory, rocks 430 million years old, and perhaps younger, lie buried beneath the Triassic rocks. Another possibility is that the younger rocks moved upward (to the left) along a gently dipping thrust fault at this contact and were eroded before Triassic time. A third possibility is that this line represents an old erosion surface on which Triassic sediments were subsequently deposited. Such a surface, would then have the characteristics of a soil and rock-rubble horizon.

Examination of the Highspire exposures has added valuable new data. At this locality, the contact dips irregularly and gently south, with no evidence of a steep border fault present. Mineralogical studies of the rocks at and below the contact indicate clay minerals that are typical of deep weathering such as would be present in an old soil horizon. However, there also is clear evidence of low angle faulting in rocks both above and below the contact. It appears that, here at Highspire, Triassic rocks were deposited on a gently south dipping erosion surface, and both the Triassic and Paleozoic rocks were subsequently faulted. Yet the controversy cannot be settled by one exposure and thus more work is needed to define the nature of this contact more clearly.

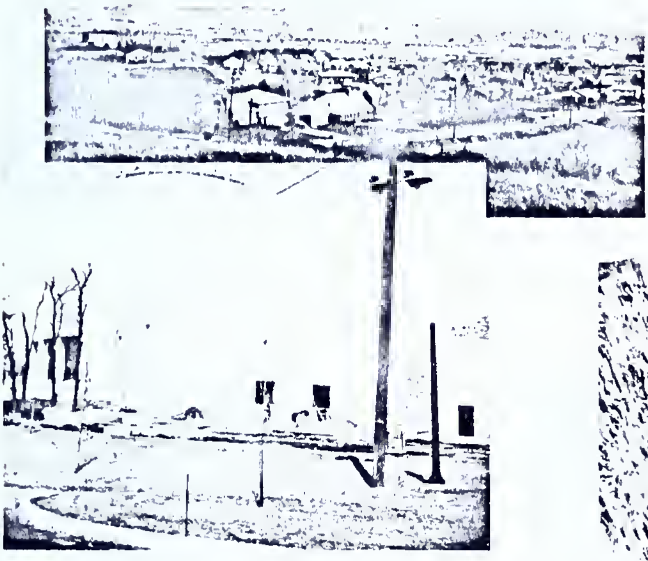
D. M. Lapham
R. Faill

SURVEY REPORTS ANSWER MANY QUESTIONS

ARE URBAN GROWTH AND MINERAL EXTRACTION COMPATIBLE?

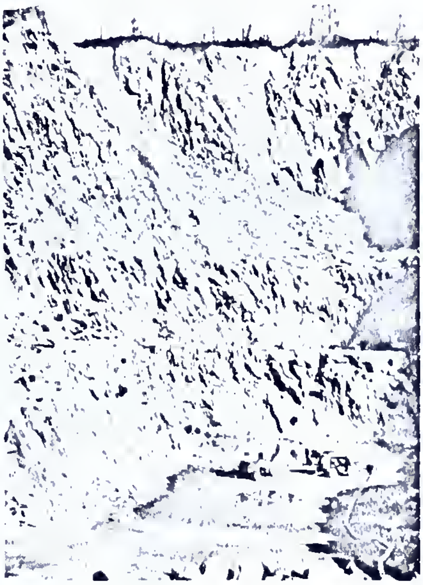
CAN MULTIPLE LAND USE SOLVE THIS DILEMMA?

FAST GROWING COMMUNITIES
NEED CONSTRUCTION MATERIALS . . . .

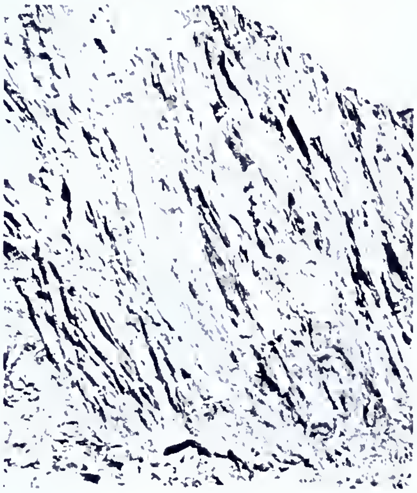


SAND & GRAVEL

STONE



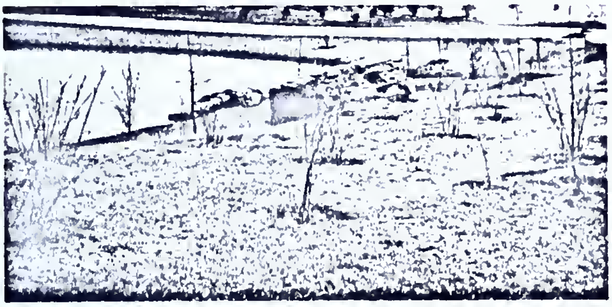
SHALE



TO KEEP COSTS DOWN
THESE MINERAL RESOURCES
MUST BE CLOSE TO USE

GEOLOGIC MAPS AND REPORTS TELL
WHAT IT IS.
WHERE IT IS.

URBAN GROWTH AND MINERAL EXTRACTION ARE COMPATIBLE!



MULTIPLE LAND USE MAY SOLVE THE DILEMMA ....

WISE COMMUNITY PLANNING PERMITS:

MINERAL EXTRACTION

FOLLOWED BY:

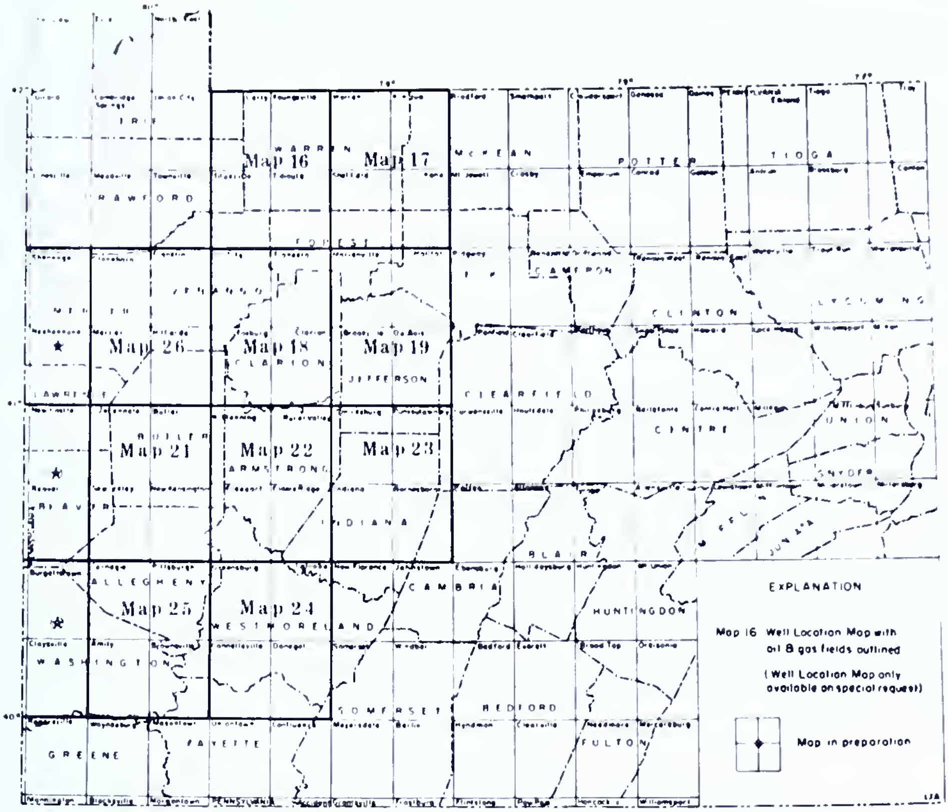
INDUSTRIAL SITE

GREENBELT AREA

RESIDENTIAL USE

SANITARY LANDFILL SITE

William G. McGlade
Alan R. Geyer



NEW AND UPDATED OIL AND GAS BASE MAPS

Demand has continued to exceed expectations for the Survey's Oil and Gas Base Map Program, now one year old. Additional printing has been required. Six months updated (posted date January 1, 1971) prints of the oil and gas base maps with gross field limits, are now available. In addition, prints of three new base maps can be obtained. Available base maps now include:

Designation	**Quadrangles Encompassed by Mapped Area**
Map 16	Corry, Tidioute, Titusville, Youngsville
Map 17	Kane, Kinzua, Sheffield, Warren
Map 18	Clarion, Foxburg, Oil City, Tionesta
Map 19	Brookville, DuBois, Hallton, Marienville
Map 21	Zelienople, Butler, Sewickley, New Kensington
Map 22	Kittanning, Rural Valley, Freeport, Elders Ridge
Map 23	Smicksburg, Punxsutawney, Indiana, Barnesboro
Map 24	Greensburg, Latrobe, Connellsville, Donegal

Map 25	Carnegie, Pittsburgh, Amity, Brownsville
Map 26	Stoneboro, Franklin, Mercer, Hilliards

Paper prints of the bases with field limits can be obtained by writing to the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pennsylvania 17125. Cost of each map is $0.50, plus 6 percent state sales tax. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering please specify the map number.

An index showing the location of the completed bases may be obtained upon request from the Pittsburgh Branch of the Pennsylvania Geological Survey, 401 Pittsburgh State Office Bldg., 300 Liberty Ave., Pittsburgh, Pa. 15222.

CURRENT ENERGY SHORTAGE

A hundred years ago seventy-three percent of the total energy used by the United States came from burning endless cords of wood. Today seventy-five percent of the energy is supplied by petroleum (oil and gas). At the turn of the century coal became our prime fuel while at mid-century coal was overtaken by crude oil. A few years later natural gas demoted coal to a third rank energy fuel. Some time in the 1980's coal may again be outranked, this time by nuclear energy. At present the United States energy consumption percentage by energy source is 43.7 oil, 31.1 gas, 21.4 coal, 3.7 hydropower, and 0.1 nuclear.

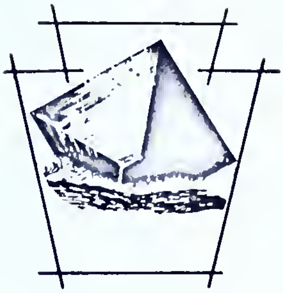
The current shortage of fuel to supply our energy, which is reflected in a short supply of residual fuel oil, a fuel which is in high demand by industry to overcome the shortage, was caused by the following factors:

1. The loss of 1,000,000 barrels a day of oil west of Suez and close to world markets through failure and disrepair of the Trans Arabian Pipeline and a cutback of Libya's oil production.
2. A shortage of natural gas.
3. Failure of completion of nuclear power plants within the time frame originally planned.
4. Failure of coal producers to meet the increased demands for coal.
5. The relatively recent regulatory developments relating to the composition of fuels or the emissions from their burning, imposed as environmental conservation measures.

Therefore, a shortage during the winter months of 1970-1971 of up to 250,000 barrels per day of residual fuel oil is a contingency which must be recognized. To overcome this shortage Texas and Louisiana have increased their output of crude oil. In addition to accommodating all the normal year-to-year growth in crude oil demand, both foreign and domestic, adjustments are now being made in normal refining patterns to make an additional 200,000 barrels a day, or more, of residual fuel oil available to the East Coast area where the shortage occurs.

If the 1970-1971 heating season should be very cold, supplies of residual fuel oil would be tight and in some areas critical even with the above adjustments in refining patterns.

William S. Lytle



EARTH SCIENCE TEACHERS' CORNER

EARTH SCIENCE TEACHERS' PACKET

The United States Geological Survey has prepared a packet of free materials to be sent to earth science teachers. This packet contains many general brochures and booklets on your local area.

Requests for the packet should be addressed to:

Geologic Inquiries Group
U. S. Geological Survey
Washington, D.C. 20242

Requests must be written on letterhead stationary showing the school or district where you teach.

OUTSTANDING EARTH SCIENCE TEACHER AWARD

This year the National Association of Geology Teachers has initiated a new program - Awards for the Outstanding Earth Science Teachers in the United States. This first year the awards will be available only to NAGT members but starting the 1971-72 school year, these will be available to any earth science teacher, whether he be a member or not.

Any secondary school teacher who is an active member of NAGT and who is presently engaged in teaching earth science to secondary school students in the U. S. is eligible. He may be teaching in a public or private school, be teaching earth science, geology, environmental science, or general science with major emphasis on the earth sciences. No restrictions will be placed on any person by virtue of race, color, creed or place of natural origin.

Nominations for this award may be made by anyone who knows the nominee and feels he is qualified. Within the Eastern Section there will be a Section winner as well as individual state winners. The deadline for nominations is March 1st, 1971. All moninations should be sent to Alan R. Geyer, Chairman, Education Committee, Eastern Section NAGT, c/o Pennsylvania Geological Survey, Harrisburg, Pa. 17120.

Awards of scientific equipment and of certificates to the state winners and Section winner will be made at the Eastern Sections' annual spring meeting at Millersville State College.

NATIONAL ASSOCIATION OF GEOLOGY TEACHERS (NAGT) SPRING MEETING

The annual spring meeting of the Eastern Section of NAGT will be held this year on April 16th and 17th at Millersville State College. The theme of the sessions will be the "Appalachian Geosyncline in Pennsylvania — Old and New Interpretations." A field trip is planned. For further information contact Dr. William Jordon, Chairman, Department of Earth Science, Millersville State College, Millersville, Pa. 17551.

NEW AGENCIES IN WASHINGTON

Geologists and others interested in environmental matters will be interested in the regrouping of a number of former federal agencies to form two major new organizations during the past few months.

The **Environmental Protection Agency** (E.P.A.) has been created by shifting the Federal Water Quality Administration (from the Department of the Interior), the Air Pollution Control Administration and the Bureau of Solid Waste Management (from the Department of HEW), ecological research (from the Council on Environmental Quality), and radiation standards (from the Atomic Energy Commission). The principal roles and functions of this new agency include the establishment and enforcement of environental protection standards, conducting research on adverse effects of pollution and methods and equipment for controlling it, assisting others in combating pollution through grants and technical assistance, and working closely with the Council on Environmental Quality in formulating new policies for environmental protection.

The **National Oceanic and Atmospheric Administration** (NOAA) has been created in the United States Department of Commerce by bringing together the Environmental Science Services Administration (ESSA) (which includes the Weather Bureau - now to be called the National Weather Service, and the former Coast and Geodetic Survey), most of the Bureau of Commercial Fisheries (formerly in Interior), the Marine Game Fish Research Program of the Bureau of Sports Fisheries and Wildlife (formerly in Interior), the Office of Sea Grant Programs (formerly in National Science Foundation), the U.S. Lake Survey (from the Dept. of the Army), and the National Oceanographic Data Center (formerly in the Dept. of the Navy). The mission of NOAA is to organize a unified approach to the problems of the ocean and the atmosphere.

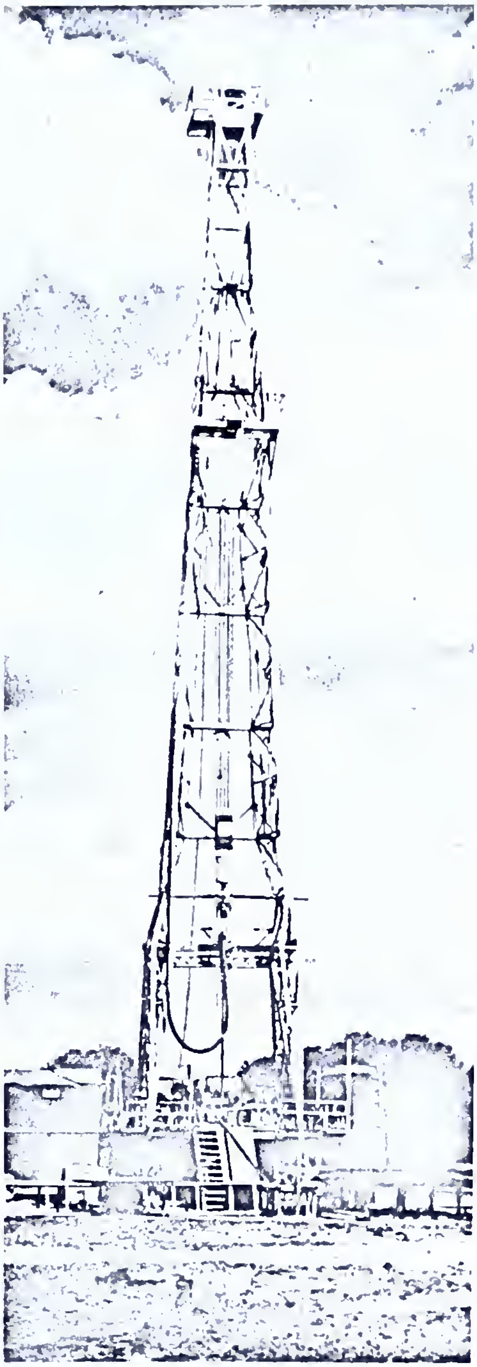
That is really quite a reshuffle. As fellow environmentalists, we wish them every success.

INDIANA COUNTY GAS WELLS

Good gas production is indicated for the developing Grip fractured Chert-Oriskany pool in eastern Indiana County. The 8,000 foot deep pool was discovered in December of 1969 by the Felmont Oil Corporation, #1 Hanwell Jr., wildcat, some five miles northeast and on structural trend with the old Chert-Oriskany Nolo field. The discovery was completed on a faulted anticline for 6.2 MMCFGPD. Two offset wells have been reported by Felmont completed to date, one for 10 MMCFGPD, the other for nearly 4 MMCFGPD.

NEW WELLS IN OLD FIELDS

The historic oil and gas fields of Pennsylvania continue to result in good completions. At least seven new development wells in the turn of the century old shallow Venango Sandstone fields of Forest and Venango Counties have reported in excess of 50 barrels of oil per day on initial production tests. Some eight new development wells drilled within the eastern edge of the deeper Upper Devonian gas sand belt of Clearfield, Indiana and Jefferson Counties have been completed for excess of 2 MMCFGPD.



RECORD WELL

A new world's depth record was established when Placid Oil Co. No. 1 Louisiana State Lease No. 5407 was abandoned at 25,600 feet. The St. Bernard Parish test was drilled 260 feet deeper than the old record well, the Phillips No. 1 EEE University in Pecos County, Texas.

SURVEY ANNOUNCEMENTS

NEW PUBLICATION HIGHLIGHTS OIL & GAS POTENTIAL

The Pennsylvania Geological Survey is pleased to announce the release of Bulletin M65, *The Petroleum Industry and the Future Petroleum Province in Pennsylvania,* 1970, by D. R. Kelley, W. S. Lytle, W. R. Wagner, and L. Heyman.

With the demand for energy growing at an ever-increasing rate, and at a time when the Nation is faced with immediate and long-range shortages of energy resources, the Pennsylvania Geological Survey believes it is particularly appropriate to present this analytical enumeration of oil and gas potential in the Commonwealth.

Pennsylvania has long been an important oil and gas producing state. In 1970 there were nearly 60,000 operating oil and gas wells in the Commonwealth. Yet now, 111 years after oil in North America was first brought into production at the Drake Well in Titusville, Pennsylvania, it seems incredible that some 83% of the volume of Pennsylvania's petroleum province remains untested. Beneath the heavily drilled Devonian oil and gas belts of the Plateaus Province lies from 5,000 to more than 20,000 feet of Cambrian, Ordovician, and Silurian strata which contain less than two wells per 25 square miles. These strata, hardly touched by the drill in Pennsylvania, are productive in surrounding states. The present and future need for hydrocarbons combined with proximity to expanding industrial areas should provide the incentive for rebirth of the industry in Pennsylvania.

We sincerely hope that this publication will stimulate exploration in Pennsylvania's large and widely untested oil and gas province. We believe that such exploration will result in important new discoveries of oil and gas which will materially contribute to improvement of the energy resources picture of the future.

Bulletin M65 is available from the Bureau of Publications, Department of Property & Supplies, P.O. Box 1365, Harrisburg, Pa. 17125, for $ .60, plus State Sales Tax.

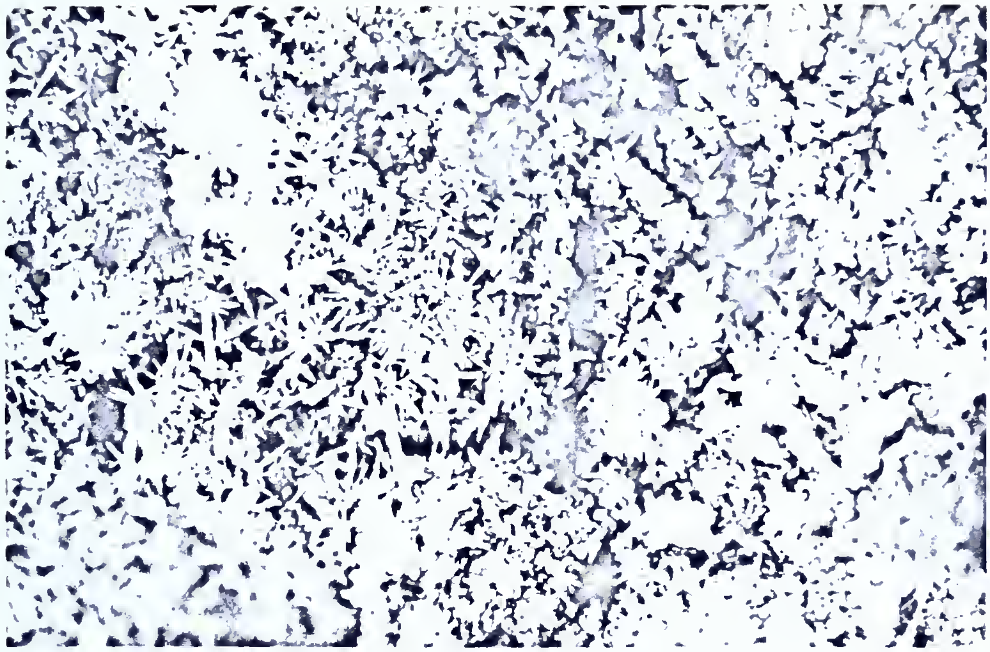
NATIVE SULFUR IN PENNA.

As a chemical element, sulfur (also spelled sulphur) is a common constituent of the Earth's crust. It averages about 520 grams per ton, or about 1-1/4 pounds per ton, for all rock types. In fact, rather surprisingly it is more abundant than calcium, the major element in limestone. Sulfur is most abundant in sedimentary rocks, particularly in shales and organic sediments such as coal. However, most of this sulfur is not present as the element, called native sulfur, but is present as a sulfate (sulfur-oxygen compounds) or as a sulfide (metallic elements compounded with sulfur).

Native sulfur is rather rare so that two occurrences recently found in Pennsylvania are of unusual interest. Most native sulfur in the United States occurs along the Gulf Coast where it is associated with salt domes and is extensively mined. In Pennsylvania, native sulfur has been reported previously at six localities, although others surely exist. Samuel Gordon in his "Mineralogy of Pennsylvania" (1922) lists an occurrence of sulfur crystals at the old Wheatley lead and zinc mines in Chester County, at the Burning Mine (anthracite) in Carbon County, and in Montgomery County at Barren Hill and King of Prussia. Most of these localities are now either inaccessible or the native sulfur cannot be found. Lapham and Geyer in "Mineral Collecting In Pennsylvania" (Pennsylvania Geological Survey Bulletin G-33, 1969) list two more occurrences in limestone: at Salona in Clinton County and in the Nippenose Valley, Lycoming County. In addition, some native sulfur probably occurs in Pennsylvania coal beds, but it cannot be seen with the naked eye. Most of this organic-associated sulfur is present as a sulfate or a sulfide.

One of the two new localities for native sulfur in Pennsylvania is at Chestnut Hill near Columbia, Lancaster County. This is a locality where there are abundant, large, and well-formed pyrite crystals that have altered to limonite cubes called pseudomorphs (see "Mineral Collecting In Pennsylvania", p. 90-92). The native sulfur occurs sparingly inside these altered cubes as pale yellowish green masses. To date, none of these masses has shown any crystal form. However, an x-ray pattern identified by John Barnes of the Pennsylvania Geological Survey, shows that the sulfur is crystalline and belongs to the orthorhombic crystal system. The native sulfur formed by the alteration of pyrite (iron sulfide) to limonite during weathering.

The other new occurrence of native sulfur is not, strictly speaking, a "natural" occurrence. At the Kehley's Run Mine near Shenandoah Heights, Schuylkill County, there is an abandoned anthracite strip mine. At this locality there is an underground coal bed that is burning. The ground is fractured and hot gases are escaping from the burning coal below. These hot fumes are depositing sulfur crystals at the surface. The crystals are pale yellow to pale greenish yellow, very small and in groups of needle-like aggregates, but they make excellent micromount specimens (see photograph). Samples collected by



Wayne Downey of Harrisburg were donated to the Survey and currently are under study.

These occurrences of native sulfur in Pennsylvania illustrate three of the four major ways in which sulfur is formed. The Kehley's Run Mine occurrence is similar to sulfur that is deposited by volcanic activity, especially fumaroles such as those in The Valley of Ten-Thousand Smokes in Alaska. The limonite pseudomorph occurrence results from the alteration of a sulfide (pyrite) by oxidation. The sulfur in coal beds, and perhaps that in limestone, is biogenic sulfur that results from the action of sulfur-reducing bacteria present during the formation of these sedimentary rocks. Only the native sulfur associated with salt domes is missing in Pennsylvania. Thus, even though it is scarce, the major different kinds of occurrences of native sulfur are well represented here.

Sulfur is one of the few chemical elements that occurs in the native state. These occurrences described here represent a rare opportunity to see and collect a native chemical element and the opportunity should not be missed by anyone interested in the Earth Sciences.

D. M. Lapham

YORK ROCK-O-RAMA

The York Rock and Mineral Club will hold its second annual Rock-O-Rama on March 27 and 28, 1971 at the Alert Fire Co. #1 Manchester Twp. Emigsville, York County, Pa.

GAS DISCOVERY IN ARMSTRONG COUNTY

The Peoples Natural Gas, et.al. #1 Nellie C. Martin well, near the community of Muff, Wayne Township, Armstrong County, about 50 miles northeast of Pittsburgh, has been completed as a wildcat gas discovery from the Lower Devonian Oriskany Sandstone. Originally drilled to a total depth of 15,574 feet, bottoming in the Upper Cambrian Gatesburg Formation, the well tested the deep Cambro-Ordovician rocks which produce gas in Columbiana County, Ohio about 80 miles to the west. The well apparently found shows of gas in zones besides the Oriskany, but none were commercial.

The well was plugged back to 6,850 feet and completed in the Onondaga and Oriskany zones for a potential of 1.1 million cubic feet of gas per day. This discovery is important because it is less than 2,000 feet southeast of a dry hole which had found no Oriskany Sandstone at the expected horizon. This had discouraged local exploration for gas from the Oriskany Sandstone, a major reservoir elsewhere in the state. Due to the additional data obtained from the Martin well, a large area is no longer condemned for exploration. The pace of wildcatting for other Oriskany gas accumulations in this area is expected to pick up as data accumulated from field wells which will be drilled to define and develop the Martin discovery.

Louis Heyman

NEW SURVEY PUBLICATIONS

Due to an error on our part, Bulletin IC-68, "Chemical Analyses of Three Triassic (?) Diabase Dikes in Pennsylvania" by D. M. Lapham and T. E. Saylor was listed as free in the December 1970 (Vol. 1/9) issue of *Pennsylvania Geology*. The cost of the publication is $0.30. Bulletin A-157d, Geology, Mineral Resources and Environmental Geology of the Palmyra Quadrangle, Lebanon and Dauphin counties was listed as $2.50. The cost of A-157d is $2.85. Both publications should be obtained from: Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax.

We apologize for our error.

NEW RELEASES

Publication		*Price*
A84cd	**Geology and Mineral Resources of The Southern Half of The Clearfield 15-minute Quadrangle,** by Albert D. Glover, (139 p., 29 figs., 15 pls.)	$7.40
M65	**The Petroleum Industry and The Future Petroleum Province in Pennsylvania, 1970,** by Dana R. Kelley and others. (39 p., 13 figs.)	$0.60

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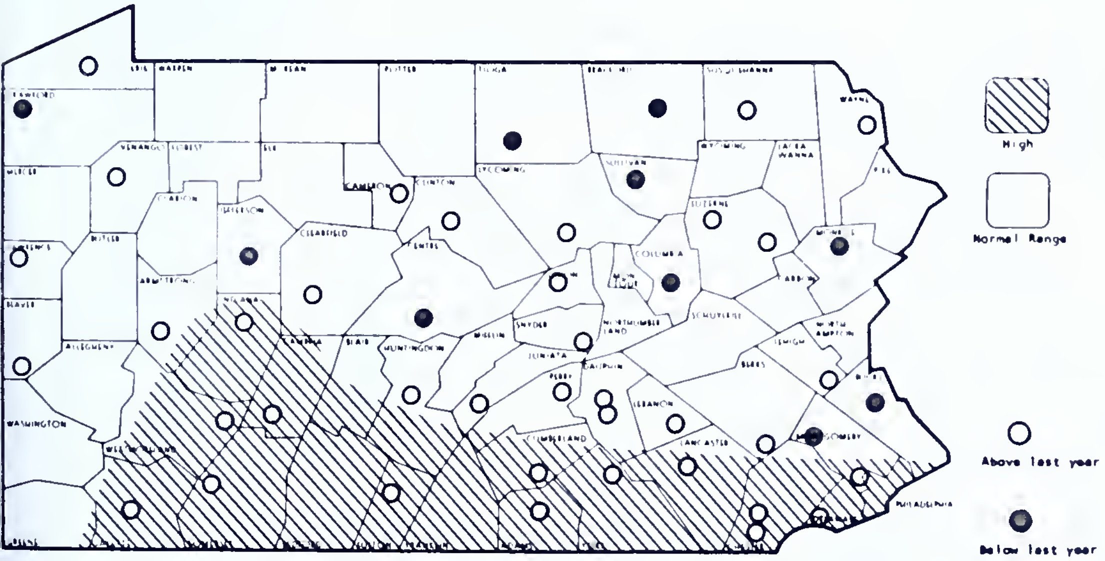

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THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 2/2

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER – Massive ice jam on Susquehanna River at Harrisburg, late February, 1971. Ice caused damming of river, with resulting flooding of adjacent lowland areas. Once ice began to move, it scoured the river banks and islands like a massive glacier. Photo by Carl Socolow.

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APRIL 1971

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

PUTTING TOGETHER IS HARDER THAN TAKING APART

We live in an age of specialization. In medicine, one doctor cares for ear troubles, another handles the dislocated knee, and a third yanks out the appendix. In the world of geology we have ground-water specialists, mineralogists, petroleum geologists, earthquake experts, coal geologists, and many, many others. As science has become more sophisticated and more specialized, we have become more and more expert at analysis, at dissecting, at taking things apart, literally and figuratively. But, there are clear indications that we have not learned as effectively how to put things together.

In planning for our environment, it is becoming increasingly clear that no single expert, nor even a group of experts in one field like geology, is going to effectively deal with the steps that must be taken to repair and protect the quality of our environment. It is becoming increasingly clear that just as there are closely intertwined relationships between our physical and biological environments, these are in turn intimately inter-related with our economic and social environments.

It was my privilege recently to participate in an AIPG-NSF sponsored workshop group of fifty professionals, including geologists, architects, planners, economists and engineers. Over the period of a few days, this group dedicated itself to "brainstorming" the problems and procedures in laying out the total scope of environmental plans for a major new city. To me, the most exciting aspect of this workshop was to observe the accelerating flow of interdisciplinary concepts pour forth as the experts in the respective fields began to recognize the needs, values, and contributions available from their colleagues in other fields.

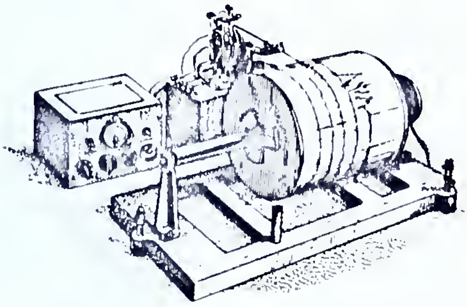
In a world that has effectively been taking things apart, it is going to require intimate, interdisciplinary communication to properly put things together again. This is a basic challenge for geologists, who in the past have left much room for improvement in communications with other professions. This is also an exciting challenge for the Pennsylvania Geological Survey, as a member of the new Department of Environmental Resources.

Arthur A. Socolow

CAN EARTHQUAKES HAPPEN HERE

As Pennsylvanians received news of the recent major earthquake in California, few realized that similar movements of the earth's crust have occurred in eastern United States. The list of historical earthquakes of record in Pennsylvania is given at the end of this article. Pennsylvania has not for 200 million years been involved in the dynamic crustal movements that occur in a mountain building zone, such as is now going on in the Pacific Coastal Ranges. The earthquakes which have been recorded here in eastern United States are believed largely due to minor crustal adjustments related to the retreat of the great ice sheet some 15,000 years ago, as well as minor stresses between continental and oceanic crustal plates. Therefore, while the California earthquakes are due to movements along many major fault lines, eastern quakes have involved very minor adjustments of major continental masses.

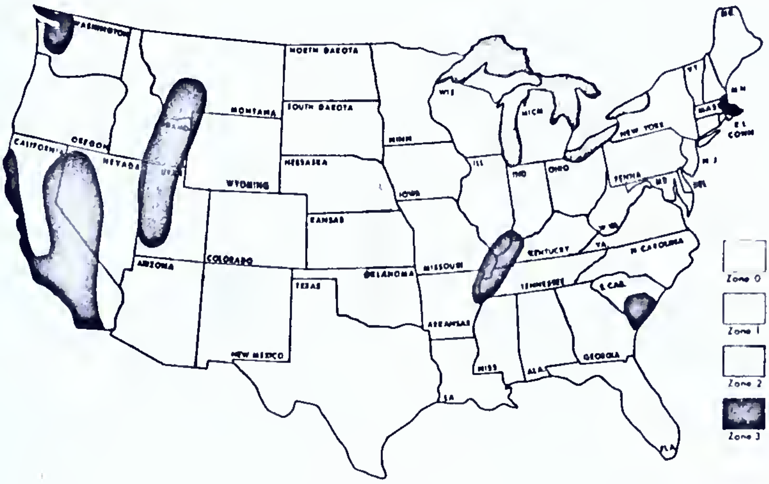
How do we measure the severity of an earthquake? The magnitude, as expressed by the *Richter Scale,* is a measure of the amplitude of the seismic waves and is related to the amount of energy released — an amount that can be calculated from seismograph recordings. This scale is logarithmic so that a recording of 7, for example, signifies a disturbance with ground motion ten times as large as a recording of 6. Earthquakes with a Richter value of 6 or more are commonly considered major in magnitude. The intensity of earthquakes is also expressed by the *Modified Mercalli Scale*; this is a measure based upon the visible effects of a shock wave at a particular location. Damage or loss of life is ultimately the most important measure of an earthquake's severity. The Modified Mercalli Scale measures this intensity in values ranging from I to XII. Examples of this scale are as follows: I - not felt except by a very few under specially favorable circumstances; V - felt by nearly everyone, many awakened, some dishes, windows, etc. broken, a few instances of cracked plaster, unstable objects overturned, pendulum clocks may stop; X - some well-built wooden structures destroyed, most masonry and frame structures destroyed with their foundations, ground badly cracked; XII - damage total, waves seen on ground surfaces; lines of sight and level distorted; objects thrown upward into air. The maximum intensity experienced in the Alaska Quake of 1964 was X; in the San Francisco Quake of 1906, it was XI.



SEISMOGRAPH. INSTRUMENT WHICH MEASURES INTENSITY OF SEISMIC SHOCKS FROM EARTHQUAKES.

The U. S. Coast and Geodetic Survey of the new Environmental Protection Agency publishes the results of its teleseismic and cooperating stations monthly and quarterly. Pennsylvania has a cooperating station in this network of seismological observatories in Philadelphia at the Franklin Institute.

In 1969, the U. S. Coast and Geodetic Survey published a seismic risk map which divides the United States into four zones: Zone 0, where there is no reasonable expectance of earthquake damage; Zone 1, where minor earthquake damage can be expected; Zone 2; where moderate damage can be expected and, Zone 3, where major destructive earthquakes may occur. Pennsylvania has been classed in Zone 1.



SEISMIC RISK MAP

Most of the quakes which have had their epicenters (the point on the earth's surface directly above where an earthquake's energy originates) in Pennsylvania and near-by states, are probably not caused by the type of internal stresses that cause a fault to move. Geologists believe that some Pennsylvania quakes of record may have had their origin in the collapse of limestone caverns, or a subsidence of underground mines.

At times, an earthquake with its epicenter outside the state will have noticeable effects within Pennsylvania. Following the major earthquake in Alaska in 1964, water in wells across Pennsylvania rose perceptably for a brief period of time due to the shock wave from that earthquake.

The prediction of earthquakes is one of the objectives of current studies by the U. S. Geological Survey and other scientific agencies. Short- and long-range predictions of earthquakes is of vital importance. It will enable man to reduce damage and loss of life from this destructive phenomenon.

At present the ability to predict the time, place, and size of earthquakes is very limited. However, even in frequently affected areas, earthquakes do not have to be disasters. Effective zoning and good construction practices are the key to earthquake-resistant communities. In the West, however, as the population has increased, expanding urban development and construction works have encroached upon areas susceptible to earthquakes, often with disregard to repeated warnings. Pennsylvania, fortunately, is not faced with this serious problem.

Barbara Conrad
Alan Geyer

RECORDED EARTHQUAKES IN PENNSYLVANIA

Location	Date	Intensity M. M.	Remarks
NE United States	Oct. 1727	V	Shocks of an earthquake were felt at night at Phila., New York and Boston which "set the clocks to running down and shook china from shelves".
Newbury, Mass.	Nov. 9 1727	VIII	A heavy shock at 10:40 p.m. at Newbury, Mass., felt from Kennebec River, Maine to the Delaware River.
Montreal, Canada	Sept. 16 1732	IX	Quake occurred at 11 a.m. reportedly felt at Annapolis, Md. Probably felt in eastern Pennsylvania.
New York City	Dec. 18 1737	VII	11 p.m. a sharp shock was felt at Phila. and New Castle, Delaware.
Cambridge Mass.	Nov. 18 1755	VIII	An earthquake centering near Cambridge Mass. was felt from Nova Scotia to as far south as the Chesapeake Bay and doubtless in eastern Pennsylvania.
Annapolis, Md.	Mar. 22 1758		A sharp shock was felt at Phila. between 10 and 11 p.m.
Annapolis, Md.	Apr. 29 1758		A shock lasting 30 seconds at Annapolis, Md. preceeded by subterranean noises. It was also felt in Phila. at 9:30 p.m.
Philadelphia, Pa.	Oct. 30 1763		A rumbling noise and shaking and trembling of the ground occurred at about 2:30 p.m.
Philadelphia, Pa.	Apr. 25 1772		A slight shock felt in Phila. at 8 a.m.
New Hampshire to Pennsylvania	Nov. 29 1783	V	Three shocks felt from New Hampshire to Pa. The first smart one was felt in Phila. on Sat. night at 10:15, a less violent shock at 1:00 Sunday morning. Houses were shaken and china thrown from shelves. People were wakened from their sleep.
East Haddem, Conn.	May 18 1791	VIII	Quake centering at East Haddem shook down walls and chimneys. Was felt in Phila.
Philadelphia, Pa.	Mar. 17 Nov. 29 1800		Severe shocks at Philadelphia.
New Madrid, Mo.	Dec. 16 1811	XII	In Phila. a "sensible undulation" on Dec. 16 at 3 a.m.
New Madrid, Mo.	Jan. 23 Feb. 7 1812		Three great earthquakes centering at New Madrid seriously affected 30,000 sq. miles were felt in Penn. and as far as Boston Mass. Probably the greatest known and most severe recorded earthquakes in the history of North America to date.

Location	Date	Intensity M. M.	Remarks
Philadelphia, Pa.	Jan. 8 1817		"River very agitated by an earthquake southward"; tossed vessels about; water rose one foot.
Philadelphia, Pa.	Nov. 11 14 1840		Severe shakes at Philadelphia were accompanied by a great and unusual swell on the Delaware River.
Rhode Island, Conn., N. J. and Pa.	Sept. 9 1848		A shock was felt in Pennsylvania, New Jersey, Connecticut and Rhode Island.
New York	Oct. 23 1857	VI	Was felt from Port Hope Ontario, on the north shore of Lake Erie, Dayton, Ohio and Warren, Pa., It was severe at Buffalo N. Y.
Canada	July 6 1873		Felt in Pennsylvania.
Burlington, N. J.	Sept. 10 1877	IV V	In Delaware Valley, Trenton to Philadelphia a shock was felt over an area 20 mi. wide with a center near Burlington, N. J.
Philadelphia, Pa.	Mar. 25 1879	IV V	On the Delaware River below Phila; felt from Chester, Pa. to Salem, N. J., over a distance of 30 miles. Felt most strongly on the east side of the river.
Allentown, Pa.	May 31 1884	V	A strong shock at Allentown; dishes thrown from table; center of Allentown.
New York City, N. Y.	Aug. 10 1884	VII	Strong earthquake affecting New England and Middle Atlantic States, with center in New York City; felt from Portland, Maine to Richmond, Va. and from the coast to N. W., Pennsylvania.
Charleston, S. C.	Aug. 31 1886	X	One of the most important earthquakes in the U. S.; the great shock at Charleston occurred on Aug. 31; felt at Boston, Milwaukee, sharply at New York City, in Cuba and Bermuda. Felt lightly in the Appalachian region of Pa. Shocks began at 9:51 p.m. with major shocks at 21:51 and 21:59.
York, Pennsylvania	Mar. 8 1889	V	Felt at Harrisburg, York, Phila., Reading and other places; center at York.
High Bridge, N. J.	Sept. 1 1895	VI	Two distinct shocks were felt at Phila. The second and more severe, was noticed from below Wilmington, Del. as far as the eastern end of Long Island, N. Y. It was felt at Allentown and Pottstown but not at Baltimore and Washington.
Giles Co., Va.	May 31 1897	VIII	A strong shock centering in Giles Co. was felt from Georgia to Pa. and from the Atlantic coast to Indiana.
Allentown, Pa.	May 31 1908	VI	An extremely local shock at Allentown; shook down a few chimneys; accompanied by a sound like an explosion or fall of a heavy body. Possibly due to the fall of a cave roof.

Location	Date	Intensity M. M.	Remarks
Charlestown, W. Va.	April 2 1909	V VI	A strong shock at Charlestown was felt at Mercersburg, Pa.
Province of Quebec, Canada	Feb. 10 1914	VII	A shock at 13:31 centering in the Province of Quebec, was reported at Allentown and Harrisburg.
Shenandoah Valley Va.	April 9 1918	VI	Middle and north Virginia was perceptibly shaken; Shenandoah Valley strongly; sound heard over considerable distance; felt as far north as Colebrook, Lebanon Co., Pa.
Saguenay River, Quebec	Feb. 28 1925	VIII	Felt over the northeast quarter of the U.S., south to Virginia and west to Mississippi River; caused little damage to life or property.
Attica, N. Y.	Aug. 12 1929	VIII	A strong shock at Attica was felt in Ontario, and from Ohio to eastern Massachusetts; in northern Pennsylvania walls of post office in Sayre were damaged, and in Erie, windows were shaken.
Erie, Pa.	Oct. 29 1934	V	Strong local shock with slight damage at Erie, Pa.; People left theaters.
Lake Timiskaming, Ontario	Nov. 1 1935	VI	An earthquake centered 250 mi. northwest of Ottawa, Ontario was felt in Pa. and as far south as Virginia.
Morrison Cove, Blair County, Pa.	Jul. 15 1938	VI	One of three or four earthquakes with an epicenter directly at Clover Creek, Pa.; affected an area about 10 by 18 mi. around; the damage was broken dishes and fallen plaster.
Central New Jersey	Aug. 22 1938	V	Phila. and its environs felt 6 shocks in a week; they were felt north to Trenton, south to Wilmington, Dela., west to Pottstown and east to Lakewood, N. J.; the center is believed to have been less than 150 mi. from Phila. and deep within the earth.
Salem Co., New Jersey	Nov. 14 1939	V	A mild earthquake shook buildings and rattled dishes in homes in the Phila. area.
Lake Ossipee, N. H.	Dec. 20 1934	V	Strong local shock with slight damage at Erie, Pa.; people left theaters.
State College, Pa.	Oct. 16 1941		A very local shock occurred at State College; Investigations pointed to a shallow focus near the south end of the borough.
Buffalo, N. Y.	Mar. 8 1943		An earth tremor awakened people and rattled dishes in western Pennsylvania between Pittsburgh and Erie. The quake lasted 2½ seconds. No damage reported.

Location	Date	Intensity M. M.	Remarks
Cornwall, Canada	Sept. 4 1944	VIII	The epicenter was near Cornwall, 50 mi. southeast of Ottawa, Canada on the St. Lawrence River, 40 mi. below Ogdensburg, N. Y.; slightly felt in Pa., Phila., Hbg., and other places.
Sinking Spring, Berks Co., Pa.	Jan. 7 1954	VI	Shock felt at 02:25; minor damage in west section of town; furniture upset; dishes and bottles tumbled from shelves; many smaller shocks felt during the month in the vicinity of Sinking Spring.
Wilkes-Barre, Pa.	Feb. 21 1954	VII	Local shock caused extensive damage in five block area; hundreds of homes affected; streets and sidewalks cracked; gas and water mains snapped; total damage est. at one million dollars; shock felt at 15:00.
Wilkes-Barre, Pa.	Feb. 23 1954	VI	Shock at 22:55; local with effects similar to one of Feb. 21st.
Lehigh Valley, Pa.	Sept. 14 1961	V	Shock felt at 21:17; many awakened and alarmed at Bethlehem, Allentown, Coplay, Catasauqua and Hellertown; buildings shook and loose objects rattled.
Pennsylvania New Jersey Border	Dec. 27 1961	V	Shock at 12:06 at Bristol and in NE part of Phila.; buildings creaked and dishes rattled; felt at Levittown and Langhorne.
Alaska	Mar. 27 1964	X	Effects of seismic waves from the quake caused rapid water level oscillation in Dauphin County wells. These oscillations averaged 0.4 feet.
Cornwall, Pa.	May 12 1964	V VI	Shock lasting less than one minute at 2:45 a.m.; Residents reported rattling dishes, items falling off shelves; magnitude 3-4.
Western N. Y.	Jan. 1 1966	VI	Felt in NW, Pa.; shock occurred at 08:23; magnitude 4.7 at origin; intensity IV at Warren, I-III at Erie, Knoxville, and Titusville.

COMPUTER PROGRAM FOR COAL ANALYSES

Recent coal analyses of core samples from the Houtzdale area of Clearfield and Centre Counties, Pennsylvania, were reported only on an "as received" basis. Since both "moisture-free" and "moisture and ash-free" upgrading of these analyses were desired for comparative purposes, a computer program was designed to perform the necessary calculations and print out the upgraded analyses. The program was written for the Pennsylvania Geological Survey's Olivetti-Underwood Programma 101 electronic desk computer and recorded on a magnetic reader/recorder card. By recording the program on this card, it could be stored and fed into the computer whenever needed. The program is capable of upgrading fixed carbon, volatile matter, ash, sulfur and British Thermal Unit values since these are the parameters reported in the pertinent analyses.

The program was made by translating two basic formulas into computer language and programming the computer to perform the appropriate calculations necessary to upgrade the analyses. For example, each item in the analyses to be upgraded to a "moisture-free" category is multiplied by:

$$\frac{100}{100 - \text{the "as received" moisture content}}$$

In the case of upgrading to a "moisture and ash-free" basis, the analyzed item is multiplied by:

$$\frac{100}{100 - (\text{"as received" moisture + ash content})}$$

In computer language the completed program reads as follows:

Step	Instruction	Step	Instruction	Step	Instruction
1	100 e↑	23	S	43	C↓
2	AV	24	B↑	44	X
3	S	25	S	45	A◊
4	S	26	b↑	46	B↓
5	d↑	27	S	47	D x
6	d↓	28	C↑	48	A◊
7	S	29	S	49	b↓
8	E↑	30	c↑	50	X
9	E+	31	B↓	51	A◊
10	D↕	32	d x	52	C↓
11	e↓	33	A◊	53	X
12	d−	34	b↓	54	A◊
13	d↕	35	X	55	c↓
14	e↓	36	A◊	56	X
15	D−	37	E↓	57	A◊
16	D↕	38	X	58	/◊
17	e↓	39	A◊	59	/◊
18	D÷	40	C↓	60	V
19	D↕	41	X	61	S
20	e↓	42	A◊		
21	d÷				
22	d↕				

To use the program, the "as received" values of moisture, ash, volatile matter, fixed carbon and sulfur in percent by weight are typed into the Programma 101 keyboard in that order followed by the B.T.U. value per pound. The computer then prints out the upgraded analyses. An annotated sample analysis is shown below to illustrate the process.

Data keyed into computer by operator	AV	(Directs the computer to the program)
	95	(Sample number)
	0.7	("as received" moisture content)
	20.5	("as received" ash content)
	21.6	("as received" volatile matter content)
	57.2	("as received" fixed carbon content)
	4.3	("as received" sulfur content)
	12060	("as received" B.T.U. value)
Date automatically printed out by the computer	21.75206	("moisture-free" volatile matter)
	57.60268	("moisture-free" fixed carbon)
	20.64432	("moisture-free" ash)
	4.33027	("moisture-free" sulfur)
	12,144.90240	("moisture-free" B.T.U. value)
	27.41104	("moisture and ash-free" volatile matter)
	72.58851	("moisture and ash-free" fixed carbon)
	5.45682	("moisture and ash-free" sulfur)
	15,304.50180	("moisture and ash-free" B.T.U. value)

The entire process of data input and print out takes less than 30 seconds for a person familiar with the Programma 101 keyboard.

Gary B. Glass

MARAFLOODS IN PENNSYLVANIA

A second Maraflood project is being started in Pennsylvania. The operator is Quaker State Oil Refining Corporation in Warren County in the Grand Valley - Goodwill Hill Field. The project will flood about 30 acres of the First Venango sand. Water will be used as part of the flooding medium in this area where previously only gas was injected as a driving force. The project wells are currently being drilled and cored.

A pilot Maraflood project that has been in operation for over two years in the Bradford Field by Pennzoil United is being expanded to a 50 acre project with Kendall Refining Company as partner.

The Maraflood process may be envisioned as the injection into the oil producing formation of a slug of solvent, miscible with the crude oil, which may "take on" relatively large volumes of water and still retain its miscibility. The range of miscibility, then, is much greater than, for example, that of an alcohol-oil-water system. As the injected solvent comes in contact with reservoir water, the water taken on by the solvent causes an increase in the fluid viscosity at that point and concomitant higher pressure gradients. Displacement of the water phase by the solvent is inhibited in preference to that of the more mobile oil. As the percent water within the solvent become greater the liquid viscosity increases substantially and the above effect becomes even more pronounced. The mechanism, then, is a preferential oil displacement process and, as such, is ideally suited for post-waterflood recovery.

From a field test in Eastern Illinois, the results indicate that the method is technically feasible but that the economic design of the process will require further field study.

PLANNING A BETTER YORK BY USING GEOLOGY

The Pennsylvania Geological Survey is currently studying the York Metropolitan Area in southeastern Pennsylvania to determine the importance of the area's resources for the present and future needs of the people, the city, and the industries.

York was located on the western bank of the Susquehanna River because the basic needs of the people were available. The air was clean, the water was pure, the soils were good for food production, and trees were plentiful for fuel and building.

The York area grew rapidly because these resources continued to be available and because new resources were found. Limestone, slate, iron ore, and sand and clay were used by early industries. Two major transportation routes, the east-west Conestoga Road (Lincoln Highway) and the north-south Susquehanna River with its canal and barges helped York to market its products.

Today, we have the same needs but we have placed even greater demands upon our natural resources and we have developed conflicts over the use of these resources. Should we save the best agricultural land for farming? Should we restrict urban growth in our best water recharge areas? Should quarrying of materials resources be restricted in urban areas or should residential building be restricted where the best industrial minerals are located?

Since the settlement of York in 1729, when there were less than 600 people in the county, the population has increased to more than 200,000 in the greater York area.

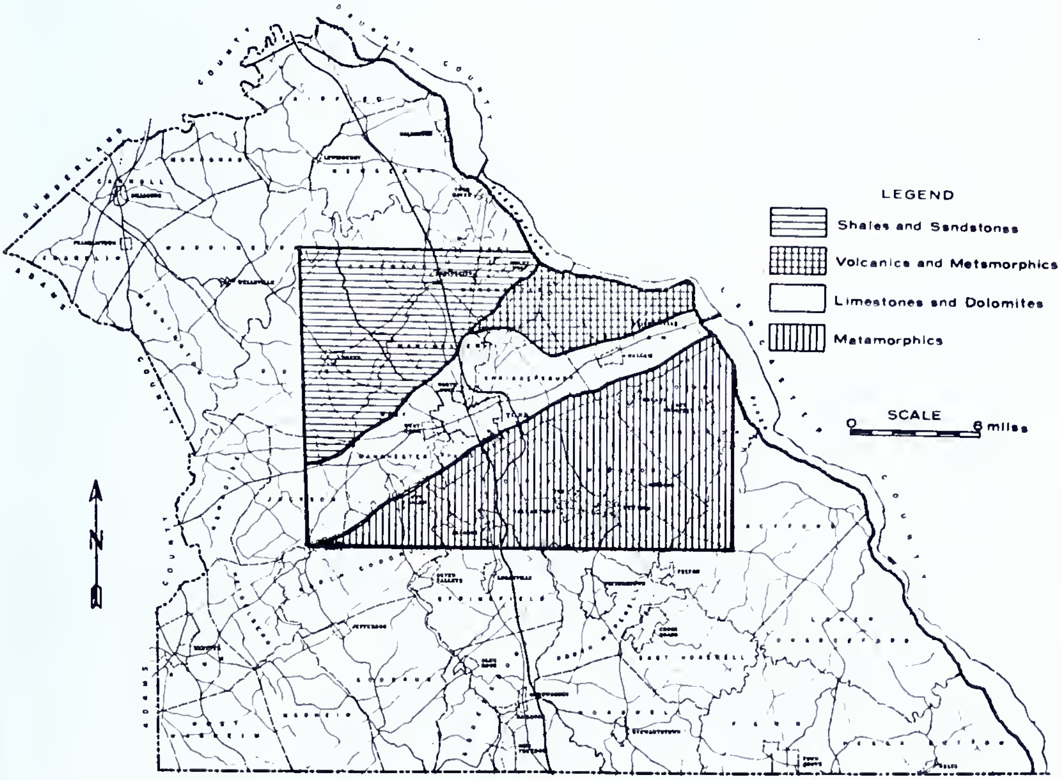
The York County Planning Commission's population estimate for the year 2000 is over 400,000 or double the current number of residents. This increase will mean that every possible source of water will have to be used. This can only be done by wise use and protection of today's water supplies. Both surface and subsurface water (ground water) must be considered in our present evaluation of resources.

AERIAL VIEW OF CONFLICTING NEEDS IN YORK AREA — MATERIALS RESOURCES, AGRICULTURE, AND URBAN GROWTH.

Are there other resources which we are reducing or consuming? The area needs more food and yet we are producing less, partially because the best agricultural land, the limestone valley, has also been the easiest to urbanize. Roads, houses, and factories are easier to build in valleys and along streams. Consequently, the urban sprawl has replaced agriculture over much of the limestone terrain (see geological map) forming the central metropolitan portion of this area. To the north is an area of Triassic shales and sandstones, less fertile for crop production, and to the south is an area of metamorphic rocks not well suited to agriculture; thus food production has been greatly restricted.

The carbonate terrain also contains the area's most valuable materials resource - limestone and dolostone. With our increased building of roads and concrete structures, the demands for this resource have also risen, but again this need is in conflict with the needs for agricultural land and for residential and industrial growth.

Geological data is important in solving these problems. The Survey project will present geological data on the York area so that the people responsible for the planning and future of the area will be able to understand and use them. The study will estimate the total amount of water available to the York area, will point out potential pollution hazards that might reduce the water supply, will report and interpret the geological factors that limit suitability of land for development, and will report the availability of materials resources.



GEOLOGY AND BOUNDARIES OF YORK ENVIRONMENTAL STUDY AREA

This information will be published as a set of factor maps. Each factor map will show the distribution of a critical factor: the topography of the area, the drainage basins, the quantity and quality of the water, the location and characteristics of the rocks and soils and their suitability for land use, and the locations of materials resources. One map will show locations of potential hazards such as floods, steep slopes, and areas of possible collapse (sinkhole failure).

These maps will also be interpreted for specific uses such as foundation stability, septic tank suitability, flood plain zoning, solid waste disposal usage, and ground water recharge. Publication of this report is expected late in 1971.

Mary E. Horne
Environmental Geologist

OIL AND GAS SQUEEZE FOR THE UNITED STATES

The United States is wholly dependent upon imports for at least 1 to 1½ million barrels per day of crude oil, the difference between our productive capacity and our demand. Domestic natural gas is nearing its maximum deliverability of 3 to 4 trillion cubic feet above 1969's production of 20.7 trillion cubic feet. These unpleasant conclusions about future producibility in the continental United States were reinforced by the recent estimated proved reserves of liquids and gas at the end of 1969 which declined for the second straight year by large amounts even though over $4 billion was spent on exploration and production in the United States. Coincident to the decline in reserves is the decline of the number of wildcat wells drilled for oil and gas in the United States over the last 11 years, from 13,191 wells in 1959 to 9,701 wells in 1969.

Even with estimated Alaska production of 2 to 3 million barrels of crude oil per day in the last half of the decade, the amount of crude oil and liquids that can be constantly supplied by the United States towards its total demand will peak at about 13 million barrels a day after 1975. The demand in 1975 will be for 17 million barrels a day with an expected growth in demand of 500,000 barrels per day each year. This indicates clearly that the United States will have to import substantially more oil or develop unconventional production from shale, coal, or tar sands long before 1980. The potential reserves from these synthetic sources amount to over 1,000 billion barrels of oil and over 500 trillion cubic feet of gas, which includes over 300 trillion cubic feet from gas buggy. Along with the necessary imports of crude oil will be the importation of natural gas (LNG) from Algeria, Nigeria and Venezuela. It is estimated that as much as half the gas needs of the Northeast United States could conceivably be met by imported LNG by 1977.

EARTH SCIENCE TEACHERS' CORNER

curriculum conference at shippensburg features field geology

The eighth annual Pennsylvania Department of Education Curriculum Conference will feature an Earth-Science Field Guide Writing Session to be held this summer at Shippensburg State College on June 22 to 25. The writing workshop will bring together earth-and-space science teachers from the south-central area of the Commonwealth who are interested in doing field work and writing. They will be assisted by members of the Earth Science Department at Shippensburg State College and the Pennsylvania Geological Survey. Teachers from other areas of the state may attend if interested and space is available.

The workshop group will be divided into two teams - one will collect field data while the other group will do the necessary writing to compile a fieldtrip guidebook for teachers and students. Emphasis will be placed upon the environmental inter-relationships of geology and man and the use of the guide by other earth and space science teachers.

The overall cost including registration, materials, room and meals is $35.00 if a room is shared and $45.00 for a single room.

For those interested in attending, application forms may be requested from Mrs. Bertha P. Boyd, Conference Coordinator, Department of Education, Box 911, Harrisburg, Pennsylvania 17126. Additional information on this particular session may be secured from Mr. William H. Bolles, Earth Science Adviser at the same address or telephone 717-787-7320. Registration for the workshop closes June 1, or earlier if the workshop quota is filled.

science theater

At the recent Geological Society of America annual meeting, several excellent films were shown. Some of these, are listed below; contact the listed producer for the conditions of availability.

How Solid is Rock? (22 minutes)

This film, designed to be stopped for discussion, deals with the factors which influence rock deformation.

Encyclopedia Brittanica Educational Corp.
425 N. Michigan Ave., Chicago, Illinois 60611

Reflection On Time (23 minutes)

An approach whereby the viewer experiences time subjectively, objectively, and geologically.

Encyclopedia Brittanica Educational Corp.

Shoreline Sediments (40 minutes)

Intended primarily for the geology student, the film examines the formation and preservation of a variety of geologic structures.

Department of Animal Genetics
Edinburgh University, West Main Rd.
Edinburg 9, Scotland

The Story of Two Creeks (30 minutes)

A field and laboratory investigation by students and their instructors. Like parts of a puzzle, the bits and pieces of evidence combine to reveal multiple glaciation at a famous Wisconsin locality.

Department of Geology
University of Wisconsin
Madison, Wisconsin 53706

Great Barrier Reef (26 minutes)

Australian ecologists, oceanographers, and zoologists describe their work at the Great Barrier Reef.

Australian News & Information Bureau
636 Fifth Ave., New York, N.Y. 10020

John Wesley Powell: Canyon Geologist (20 minutes)

This film relives the excitement of the Powell expedition through the Grand Canyon region, using point-of-view photography, excerpts from Powell's diary and explanations of the geologic wonders he encountered.

Film Documentation Unit
Center of Astrogeology
601 E. Cedar Ave., Flagstaff, Arizona 86001

Men at Bay (26 minutes)

A case history of the near-destruction of San Francisco Bay, which implies that man must control his technology before it destroys his planet.

King Screen Productions
320 Aurora Ave., North Seattle, Wash. 98109

SURVEY ANNOUNCEMENTS

GEOLOGIC REPORT ON CLEARFIELD QUADRANGLE

The Bureau of Topographic and Geologic Survey has released Bulletin A84cd. entitled "Geology and Mineral Resources of the Southern Half of the Clearfield 15-Minute Quadrangle, Pennsylvania", by Albert D. Glover. The geologic part of the report includes a description of the various rock types exposed at the earth's surface: sandstone, shale, siltstone, coal, clay and limestone. This sequence of rocks is almost flat-lying, generally dipping toward the Susquehanna River which crosses the central part of the report area. Variations in thickness and rock type are discussed in detail, and a list of the fossils that were found in the rocks is included.

The mineral resources of the area are described and located on several maps. Coal is the principal resource with estimated reserves of 86 million short tons contained in beds greater than 28 inches in thickness. Other important resources are clay, shale, sand and gravel, and ground water.

The report also lists published coal analyses as well as the petrographic composition of several coal samples from the area, in addition to chemical analyses and physical tests made on clay and shale samples collected from the Clearfield area.

It should be pointed out that this is the first Survey publication to include a map showing the foundation and excavation conditions and an evaluation of the various construction materials in a particular area. All future survey publications of this nature will have this information.

The report will be useful to the mineral industries in the area by showing where a particular mineral or rock type may be found. Professional Geologists will be able to use the basic geologic data in the report to conduct more detailed or specialized studies. Engineers will find the report helpful in evaluating future construction sites. The report will also aid conservationists in controlling pollution of the water resources of the area and in more intelligent land use.

Bulletin A84cd is available for $7.40 plus $0.45 tax from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125.

SURVEY GEOLOGISTS IN AIME MEETING

Two members of the Pennsylvania Geological Survey participated in the March 1971 Annual Meeting of the American Institute of Mining Engineers at New York City. Survey Director Arthur A. Socolow was Chairman of the session on Application of Geology and Engineering in the Industrial Minerals Industry. The papers on this program and the following discussion were pertinent to Pennsylvania's industrial mineral industry.

Karl V. Hoover, Economic Geoligist for the Survey, presented a talk on Factors Affecting the Use Potential of Clays and Shales in Pennsylvania. The paper highlighted the research findings of the Pennsylvania Survey's ongoing clay and shale program; attention was focused on those criteria which can enable rapid recognition of usable clays and shales in Pennsylvania.

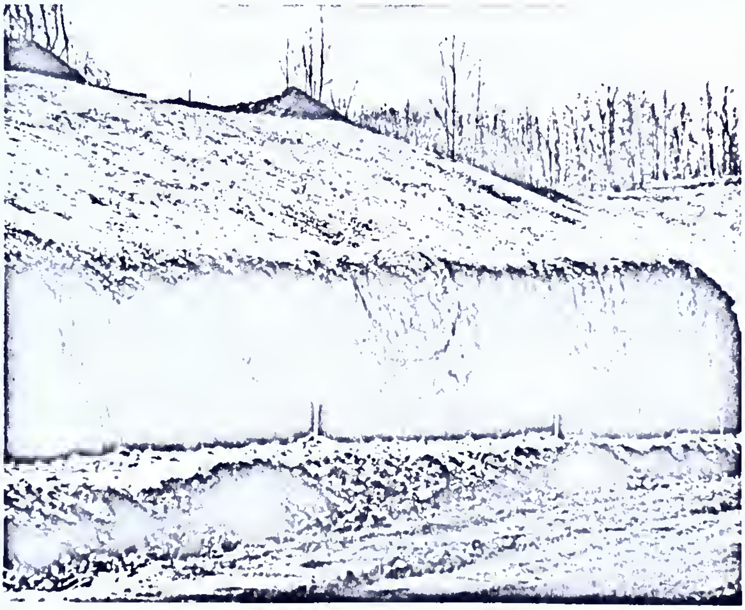
FOLD EXPOSED IN NEW CUT

One of the more interesting geologic features which can be seen along the newly opened Interstate Route 81 in southern Schuylkill County is this example of a syncline exposed in one of the highway excavations near the U. S. 209 interchange west of Tremont. The syncline can be seen on both sides of the roadway, about one-half mile north of the interchange, adjacent to the very large coal refuse bank which is visible for a considerable distance.

This is the axis of the eastward plunging Tremont Syncline, one of the major structural features in this area, which trends northeast for about 12 miles. Sandstones, shales, and the Tracy Coal vein exposed are members of the Llewellyn Formation which is of Upper to Middle Pennsylvanian Age.

During the summer months considerable acidic ground water seeps through the face of this excavation and a greenish-brown slime will be found on the rock surface. This condition is created as a result of the oxidation of pyritic materials adjacent to the coal veins by micro organisms indigenous to an acidic water.

Wendall H. Brown
Berger Associates



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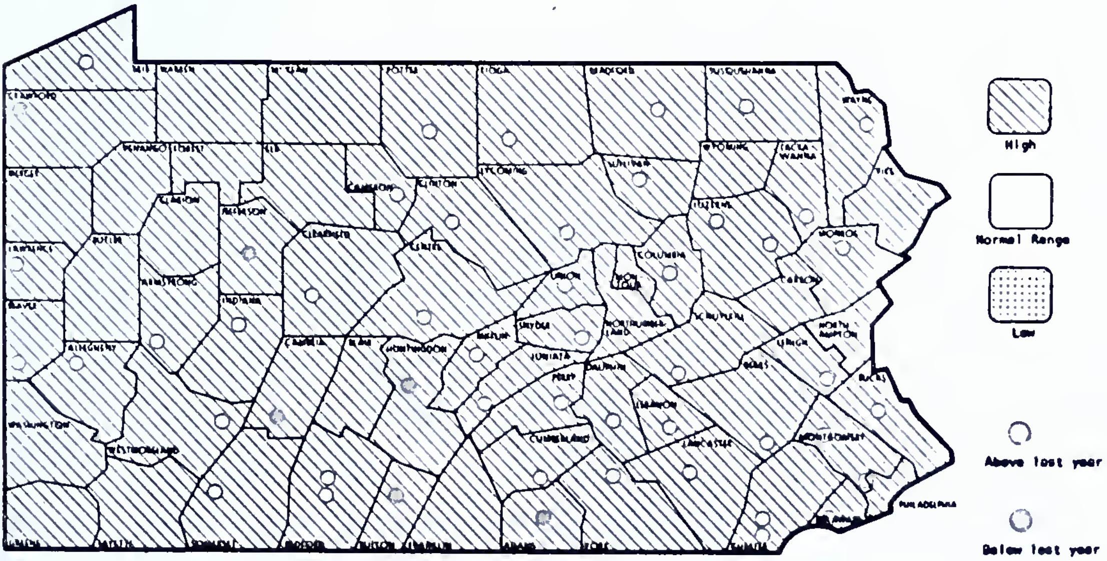
GROUND-WATER LEVELS



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GEOLOGY

NNSYLVANIA

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FROM THE DESK
OF THE
STATE GEOLOGIST . . .

ELSIE ADAMS - A SUCCESS STORY

It has been customary for the cover of this journal to carry the photo of an outstanding geological feature of Pennsylvania. In the most complimentary sense, the photo of Miss Elsie Adams carries forward this tradition. As the Executive Secretary for the Pennsylvania Geological Survey for 40 years, Elsie has been a mainstay in the effective operation of the Survey. With her impending retirement at the end of June, it is fitting that we extend our recognition and appreciation to Elsie.

The smooth and efficient operation of a geologic survey entails not only a competent and productive geological staff. It also requires someone who can see to it that the diverse wants and needs of the public are promptly handled and are meshed to the service capabilities of our staff. At the same time, the Survey staff itself must be served with a burgeoning array of administrative functions. All this, and more, Elsie Adams has done efficiently and graciously for the Survey for 40 years, always with a smile, with warmth, and with personal concern.

The success of people can be measured in many ways. None is more basic than the measure of goodness and selfless dedication to fellow man. Certainly, by these difficult standards Elsie Adams' career with the Pennsylvania Geological Survey is a success story.

I am deeply appreciative for all that Elsie has done for the Survey, for the Commonwealth, and for me. I join with a great host of her friends and acquaintances in wishing her a most happy retirement; to say that she has most certainly earned it is really an understatement.

Arthur A. Socolow

ELSIE ADAMS TO RETIRE

Miss Elsie Adams, Secretary to the State Geologist, will retire on June 30, 1971 after completing 40 years of continuous, dedicated service to the Bureau of Topographic & Geologic Survey.

Elsie started as a clerical assistant on July 1, 1931 at the magnificent salary of $900 per year. Among her first duties were care of the library, preparing records on expense accounts and auto reports and tabulating data on oil and gas production in Pennsylvania. Within a short time she became the primary typist for the many reports issued by the Survey. Elsie received continual promotions as a recognition of her proficiency and dedication and has served as personal secretary to each of the five State Geologists of the 4th Pennsylvania Geological Survey. Starting with the first State Geologist of the 4th Survey - Dr. George Ashley, Elsie has also been secretary to Dr. Stanley Cathcart, Dr. Ralph Stone, Dr. Carlyle Gray and the current State Geologist, Dr. Arthur A. Socolow. Her knowledge of Survey and governmental procedures has been a key factor in the Survey's ability to offer efficient service to all.

Elsie has seen many Pennsylvania administrations. She began her work under Gifford Pinchot and during her 40 years she has served under the following Governors: Earle, James, Martin, Bell, Duff, Fine, Leader, Lawrence, Scranton, Shafer and our present Governor, Milton Shapp. During most of her years with the Bureau it was within the Department of Internal Affairs. In December of 1969 the Bureau was temporarily transferred to the State Planning Board and then finally assigned to the new Department of Environmental Resources in January of 1971.

One of Elsie's hobbies during her years with the Survey has been to travel to many places in the world. With many of her friends and her associates from the Harrisburg Chapter of the National Secretaries Association, which she joined in 1950 and has actively supported, she has traveled several times to Europe and Mexico. Elsie plans to continue this hobby and we wish her *Bon Voyage* for all her trips.

ELSIE ADAMS AND THE FOUR PRIOR STATE GEOLOGISTS.

PLENTY OF RAIN - QUICK FREEZE - AND YOU CAN SEE SINKHOLES

A method of detecting and mapping sinkholes in the limestone areas of Pennsylvania

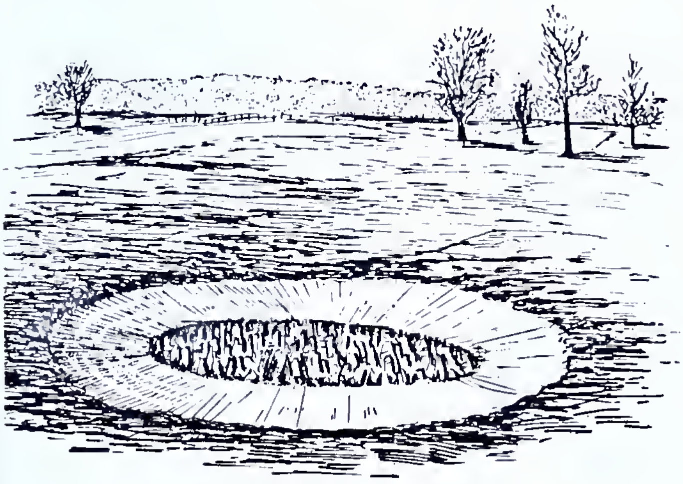
A large portion of the present and expanding part of the Harrisburg Metropolitan Area is underlain by soluble limestone and dolomite bedrock. Ground water can "dissolve" this rock to form caves, tunnels and other voids which in turn may trigger collapse of the ground surface and form what are commonly known as sinkholes.

Unless the sinkholes cause property damage or large surface collapses, they can remain undetected. Many potentially catastrophic sinkholes are reflected on the ground surface only as shallow or very subtle saucer-like depressions. Often they are obscured by cultivation or other man-made modifications of the earth's surface.

After a series of recent, fortuitous events, the Pennsylvania Geological Survey may have come across a new way of detecting and mapping these often hazardous features.

During the first 20 days of February, 1971, 3.76 inches of precipitation in the form of rain and snow were recorded; this is 2.16 inches greater than the normal amount expected for this particular period. Between 1 and 14 February, 3.54 inches of the total were recorded, including 1.62 inches of precipitation on the 13th of February and 1.38 inches on the 14th of February, 1971. Then the temperatures suddenly dropped to subfreezing levels and remained near the freezing mark until the 19th of February.

During the entire period until the 14th of February, 1971, the ground water level rose considerably and in some of the carbonate (limestone and dolomite) areas the water levels were at or very close to ground surface.



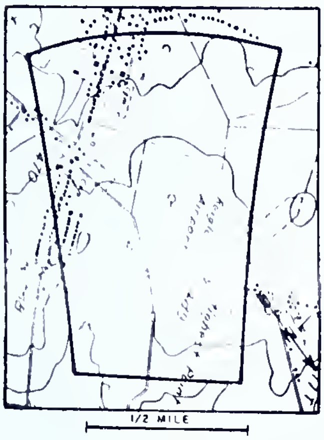
On Sunday afternoon, February 14, 1971, after the rain had stopped and the temperature had dropped rapidly to subfreezing levels, Alan Geyer of the Survey staff noticed a zoned arrangement of ice in the depressions which he knew to be sinkholes.

The ice was firm, but thin, along the rim

COMPARISON OF PHOTOS AND MAPS OF THE CAMPBELLTOWN AREA

TOPOGRAPHIC MAP (1968)
Scale 1:24,000

(A)



NO EVIDENCE
OF
SINKHOLES

AIR PHOTO-VERTICAL
13,000 feet above ground level Scale 1:30,000 (1968)

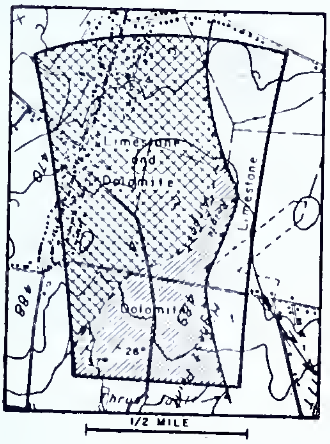
(B)

POSSIBLE DETECTION OF SINKHOLES WITH HIGH STEREOSCOPIC MAGNIFICATION

AREA COVERED BY PHOTO (D)

The irregular shape of the areas in A, B and C is caused by distortion of the "quick-freeze" photo (D) superimposed on the other distortion-free surfaces. Photo (D) was taken at a low angle and low altitude.

(C)

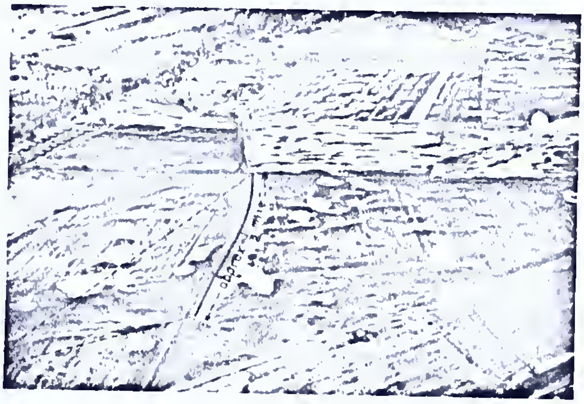


GEOLOGIC MAP (1970)
Scale 1:24,000

NO EVIDENCE
OF
SINKHOLES

"QUICK-FREEZE"
Photos 2-18-71 - Scale 1:22,000 (approx.) at this point

(D)



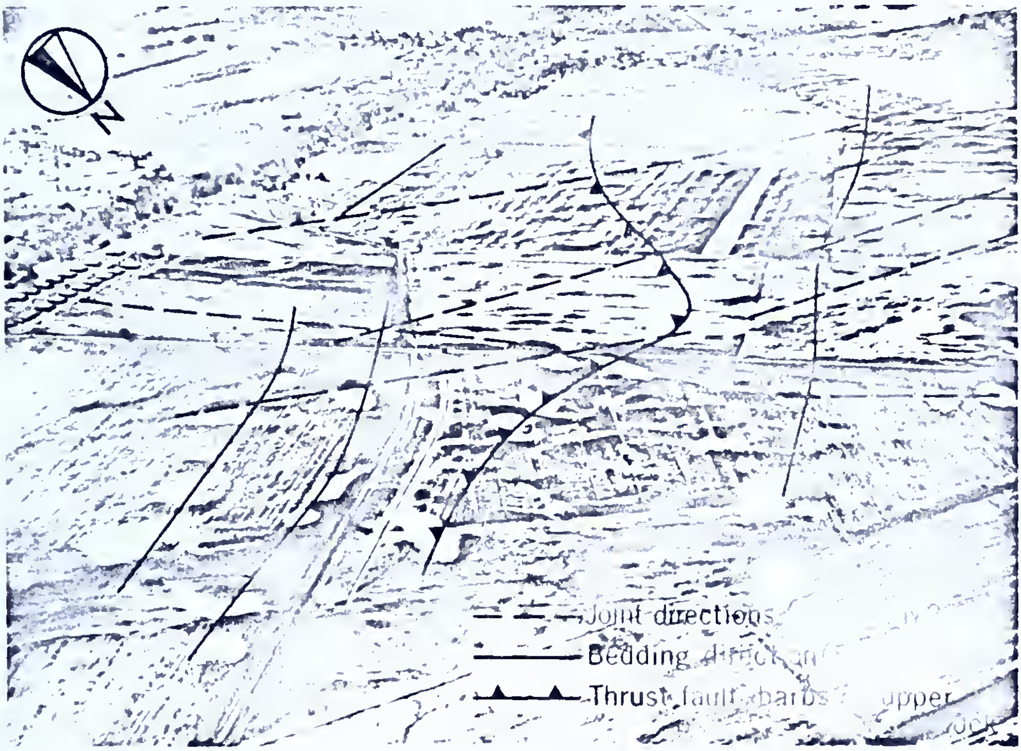
EASY DETECTION OF SINKHOLES
(White ovals, ellipses, circles, etc.)

of the sinkholes and standing on edge in parallel slabs in the center and deeper part of the sinkhole.

During the afternoon of Thursday, February 18th, Mary E. Horne and William G. McGlade of the Survey staff spent one hour conducting an aerial reconnaissance of the carbonate valley between the Susquehanna River and Campbelltown (2 miles south of Palmyra) with the intention of photographing and examining the sinkhole phenomena noted by Geyer.

In addition to an obvious use in the detection and mapping of sinkholes for safety and engineering purposes, these "quick-freeze" photos of carbonate areas can also be helpful in finding and substantiating faulting and other fracturing in the rocks. These data can be valuable aids in the development of ground water supplies and mineral deposits of any given area.

William G. McGlade



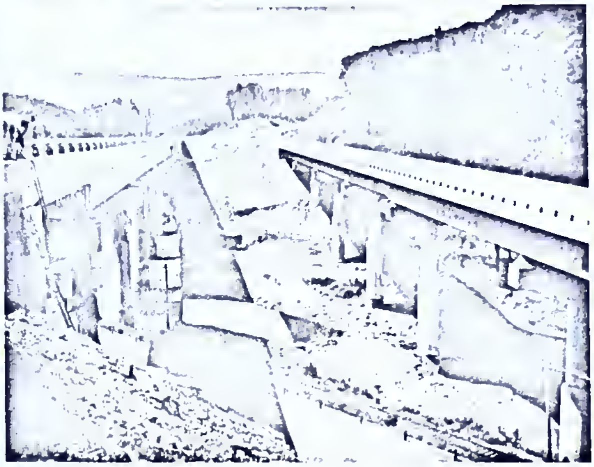
ENLARGED DUPLICATE OF PHOTO (D) SHOWING CERTAIN GEOLOGIC FEATURES. THESE FEATURES ARE VERIFIED BY FIELD INVESTIGATIONS.

DR. PECORA MOVES UP

Dr. William T. Pecora, Director of the United States Geological Survey for many years, has been designated to be Under Secretary of Interior. Dr. Pecora has supported many cooperative federal-state programs which have served Pennsylvania well. We congratulate our geologic colleague upon his most significant new assignment.

ENGINEERING CHARACTERISTICS OF THE ROCKS OF PENNSYLVANIA

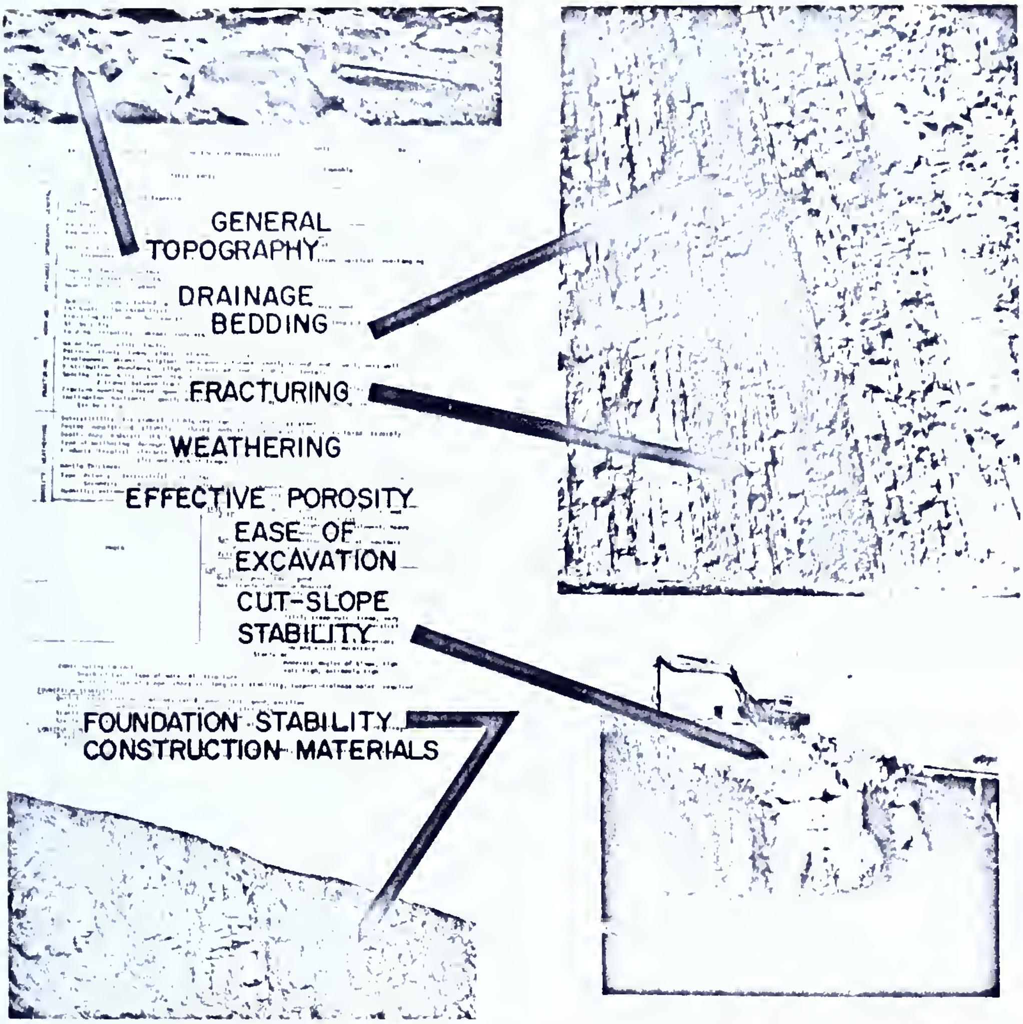
Staff geologists of the Pennsylvania Geological Survey have nearly completed an environmental geology project which summarizes the engineering properties of the rock formations exposed in the Commonwealth. This report, to be published during the late summer of 1971, has been profusely illustrated so that outstanding features of each rock formation are visible to the reader. Everyone whose construction plans involve rock will find this publication of the utmost importance.



Examinations were conducted on a statewide basis for each rock formation shown and defined on the State Geologic Map. Data were tabulated on a "field data sheet" illustrated below. Factors involved in the evaluation are both qualitative and semi-quantitative and every precaution was taken to be definitive. Certain field and laboratory test data have been included.

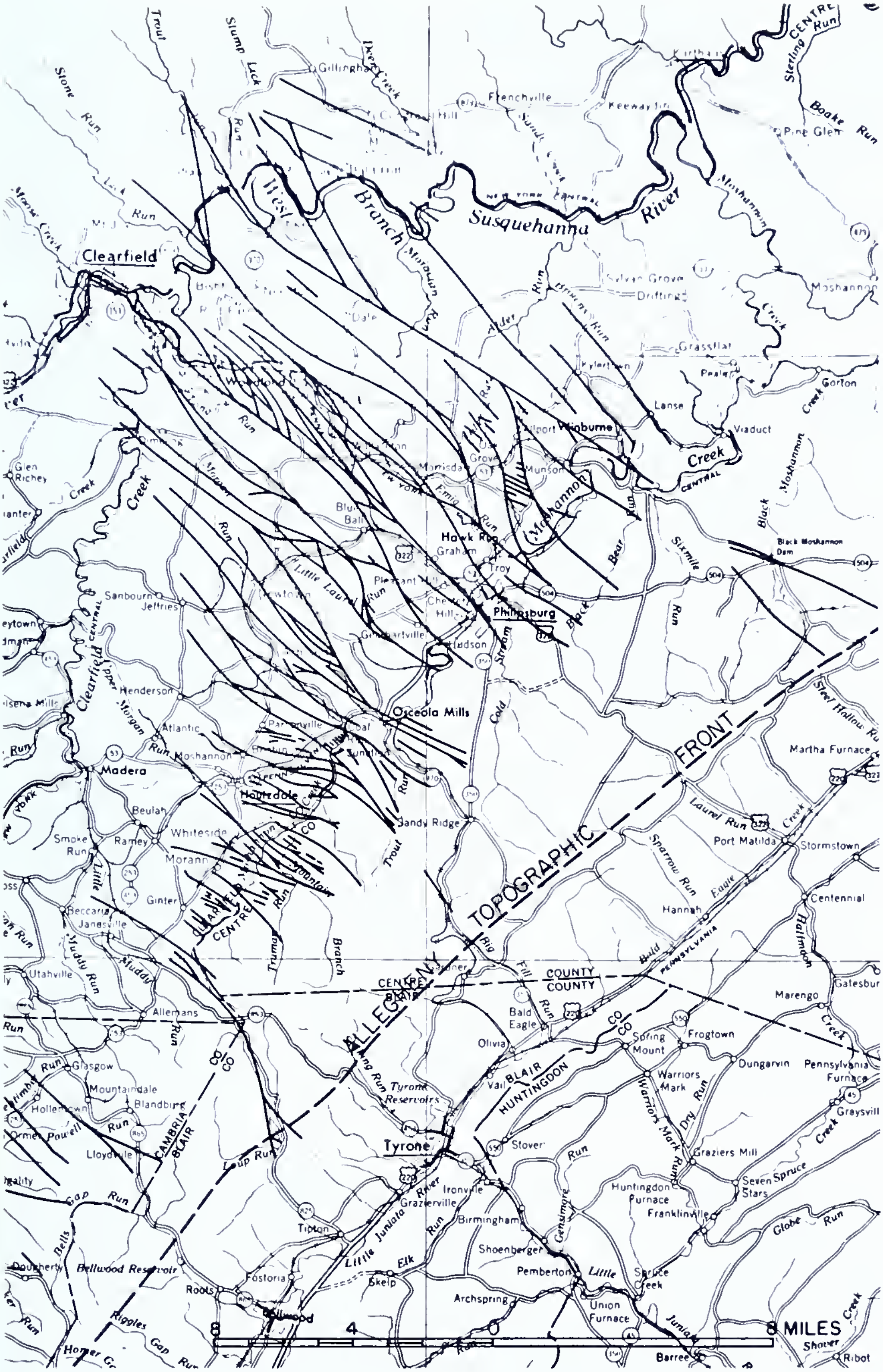
The authors are continuing this study in conjuction with other environmental geology projects of specific urban areas and general environmental geology cases.

William G. McGlade
Alan R. Geyer
John P. Wilshusen



WRENCH FAULTING IN THE APPALACHIAN PLATEAUS OF PENNSYLVANIA

Recent geological mapping by the Pennsylvania Geological Survey has delimited a zone of intense faulting that fractures the otherwise relatively mildly deformed late Paleozoic era rocks of the Appalachian Plateaus Province exposed in portions of Centre, Clearfield and some adjacent counties. To date, the greatest number of faults have been mapped in a 24 mile long zone extending northeastward from Dougherty just north of Altoona to the vicinity of Grassflat. Similar faulting is unknown in the rocks southwest of Dougherty, but three faults have been mapped between Grassflat and Waterville, which is about 45 miles further to the northeast of Grassflat. Rather than an actual lessening of fault frequency, it is more likely that the lack of detailed geologic mapping between Grassflat and Waterville accounts for the smaller number of known faults in that area.


Clearfield
Susquehanna River
West Branch
Philipsburg
Osceola Mills
Houtzdale
Madera
Tyrone
ALLEGHENY TOPOGRAPHIC FRONT
CENTRE COUNTY
BLAIR COUNTY
BLAIR
HUNTINGDON
CAMBRIA
CLEARFIELD
CENTRE
Moshannon Creek
Black Moshannon Dam
Port Matilda
Little Juniata River
Bellwood
8 4 0 8 MILES

The mapped southeastern termination of faulting generally coincides with the extreme southeastern outcrop of the Pennsylvanian coal-bearing rocks with one notable exception. Although its exact location and behavior is still somewhat questionable, one of the faults near Tipton has been traced beyond the Allegheny Front eastward into Bald Eagle Valley. The existence of this fault coupled with the good probability of several other similar faults suggests that the mapped termination of faulting in this direction may only be apparent.

The western or northwestern limit of these faults in Clearfield County has been documented by detailed mapping of that area and is indeed a real termination of the faulting. The western extent of the faults in Blair County is not certain nor is the northern extent in Clinton and Lycoming Counties.

The mapped portion of this faulted zone consists of no less than 80 major, steeply-dipping faults at trends (strikes) between N5°W and N89°W. The average strike of faulting south of Osceola is N50°W while the average between Osceola and Grassflat is N40°W. Strikes between Grassflat and Waterville seem to be more northerly, but no average has been determined. Although the faults generally parallel one another, it is not uncommon for an individual fault to exhibit some sinuosity in its trace. Many of the faults split into two separate faults along their strike while others join one another to form a single fault. Cross-faults often connect two major faults. The result is a mosaic of canoe-shaped fault blocks whose long axes trend northwest-southeast across the area.

Because of their orientation, dip and sense of movement, these faults are classified as wrench faults. In general the strike of the faults is very nearly perpendicular to the fold axes of the area. The dips on the fault planes are essentially vertical. The sense of displacement along these wrench faults is lateral movement parallel to the traces. The rocks on the eastern sides of the more northerly trending faults moved northward relative to the rocks on the opposite sides of those faults while the rocks on the eastern or northern sides of the more westerly striking faults moved instead toward the southeast. The author has recorded a few measurements of this apparent lateral displacement based on observations of plunging slickensides on some fault surfaces. These measurements of relative horizontal offset range between 1 and 75 feet and when coupled with some additional stratigraphic observations, lead the author to tentatively suggest that the apparent relative displacements along individual faults are most probably on the order of tens of feet or at the most a few hundreds of feet.

Measurements of apparent vertical displacements across faults are very common and range from a few inches to a possible maximum of 600 feet. These apparent vertical offsets average only tens of feet and vary considerably along any one fault even to the extent of reversing their relative up and down movement. Apparent vertical movements can be explained by independent vertical warping of the rocks on either side of the fault or by abutting anticlines against synclines as a result of the lateral movements along the faults.

Because these faults continue downward at least through and below the

View of a wrench fault in the Wallaceton area taken parallel to its strike. The relative movement on this fault is such that the rocks on the left side of the fault moved toward the camera while those on the right side moved away. The 5 to 10 feet of vertical offset, displayed by the pictured rider coal (black unit), is only apparent vertical displacement resulting from the lateral movements along the fault.

Close-up view of a wrench fault in the Wallaceton area with approximately 25 feet of apparent vertical displacement. The true sense of relative movement along this fault is such that the left side moved toward the camera while the right side moved away.

coal measures, they present a significant problem for the mining industry operating in this area. Underground coal mining is markedly affected by this faulting since vertical changes in the position of coal seams on opposite sides of a fault are extremely common. This problem is particularly pronounced when the relative vertical displacement across a fault is large or when a great number of small displacements continue to vertically offset the coal for any great distance across a mine. Even when it is feasible, tunnelling across faults to reach vertically displaced coal seams can be expensive and can cause a multitude of engineering, drainage, ventilation and safety problems. Additionally, modern mechanical mining equipment can be seriously damaged when it strikes an unsuspected fault surface.

Although the effect of faulting on strip mining is not generally as pronounced as that on underground mining, large vertical displacements of coal seams can terminate an operation. Even smaller vertical offsets, especially when they become too numerous, can cause serious and costly loading problems in a stripping operation. Only when the existence and location of these faults are known in advance, can a surface or underground mine be layed out to minimize faulting's effects on its operation and development.

Published geologic maps and reports in this faulted area are of William E. Edmunds, *Geology and Mineral Resources of the Northern Half of the Houtz-*

dale 15-minute Quadrangle, Pennsylvania Geological Survey, 4th Series, Atlas 85 a and b (1968); George W. Colton's, *Bedrock Geology of the Waterville Quadrangle, Lycoming County, Pennsylvania,* Pennsylvania Geological Survey, 4th Series, Progress Report 174 (1968); and Albert D. Glover's, *Geology and Mineral Resources of the Southern Half of the Clearfield 15-minute Quadrangle,* Pennsylvania Geological Survey, 4th Series, Atlas 84 c and d. Additionally, the author's report on the geology and mineral resources of the Philipsburg 7½-minute quadrangle is in preparation for printing while field work continues in the southern half of the Houtzdale 15-minute quadrangle.

Gary B. Glass

WILMERDING LANDSLIDE, COOPERATIVE PENNSYLVANIA GEOLOGICAL SURVEY EMERGENCY EFFORT

For a number of months residents of the southeast side of Russian Hill in the Borough of Wilmerding of east Pittsburgh had become aware of ground surface creep and surface and ground water drainage changes. During the week of March 8th, and after an unusual wet period, these gradual alterations culminated in the initial development of landslides. Arcuate scarps formed with attendent movement of the surface, damaging some houses and threatening damage of other houses. Foundations cracked and warped. One of the scarps transected Laveen Street (see photo). Utility lines were shifted, warped, and endangered. It was estimated some 25 families were threatened with damage or losing their homes. The danger of the developing slides was noted by widespread coverage in the news media.

Various agencies and a private engineering consulting firm responded to calls for advisory assistance and within a little more than a week emergency measures to alleviate the immediate hazard with appropriate implementation were developed. Pennsylvania Geological Survey assistance was a major factor in establishing the temporary emergency measures. Rapid compilation of existing data and reconnaissance field surveys indicated the complex nature of the landslide problem and that the geology of the area played a critical role in the hazard.

Although soil cover and development obscured bedrock conditions in the immediate area, it became readily apparent that formation of scarps was directly

related to the distribution of known hazardous mobile clay red bed zones. This rock type changes physical state from a relatively hard, shaley claystone to a grease-like mud when sufficiently wetted. The altered, now viscous rock, will flow plastically depending on over burdened pressure and/or direction of pressure release, carrying whatever rests upon it and engulfing anything over which it flows. In the Wilmerding area relatively recent alteration of natural drainage patterns enabled overlying surface and ground water to penetrate below the surface of the hillside to wet the hazardous red bed zones down slope, resulting in the creep initially noted and the development of landslides accompanying an unusual wet period.

On the basis of these and other geological considerations afforded by Survey cooperation, emergency measures are directed toward taking the water off the hazardous red beds, particularly in the developing slide areas. Prevention of penetration of overlying spring and surface water into the subsurface of the hillside and, diverting this water elsewhere, has been successful in at least temporary cessation of movement. Other emergency measures are designed to dry up the present slide area located in the midst of housing development. The Pennsylvania Geological Survey has offered its services in any further geological-engineering study required to gather the data necessary to establish permanent land stability of the area.

Dana Kelley

MORE SURVEY DETECTIVE WORK: THE CASE OF THE WAYWARD ROCKS

The Pennsylvania Geological Survey has become involved in another case of mineralogical detection: the appearance of two 30-gallon drums of "rock material" of unknown source and destination.

The story began when the Survey, as a last resort, was contacted by a major interstate trucking corporation. The identification of the sender and the destination of two drums in their Harrisburg area depot had been lost. Could we advise them if the rock-like material was valuable, or should it be discarded; or perhaps could we identify the contents to help them trace the shipment? We thought that we could, but the task turned out to be rather complicated.

The clove-brown and yellowish-white material was sampled and determined to be a slightly radioactive, processed, non-metallic concentrate. Laboratory analyses were then run: specific gravity, qualitative chemistry, x-ray diffraction, and x-ray spectrography. Finally, a definite identification was obtained. The material most certainly was valuable: a hafnium-bearing manufactured zirconium oxide with some baddeleyite. Such material is used in alloys, in nuclear reactors, in paints and enamels, and for many other purposes.

Information from the U. S. Bureau of Mines with likely sources of producers and the Survey's identification data were then submitted to the trucking company. One week later they found the sender, in southeastern United States, and the intended destination in northeastern United States. The wayward "rocks" have found their home and our geoscientists had successfully closed another case.

EARTH SCIENCE TEACHERS' CORNER

outstanding earth science teacher in 1971

Dr. Frank Roberts has been selected the Outstanding Earth Science Teacher for the 1970-71 school year by the Eastern Section of the National Association of Geology Teachers. This organization established for the first time this year an award for the most outstanding secondary school earth science teacher. Dr. Roberts was recognized for his devotion to his students; his unique ability to blend the classroom, lab, and field studies; his techniques to encourage creative thinking; and most of all his ability to be not only a teacher but also a friend and advisor both in and out of the classroom, to set a high example and inspiration for his students and collegues.

Dr. Roberts teaches at the Delaware County Christian School in Newtown Square, Pennsylvania. He has taught physics, chemistry and earth science there for more than 15 years. He has written an extensive syllabus for his earth science course at the school which is also used by several other schools. His students enjoy field trips both during regular school days as well as after school on an optional basis. During the summer, Dr. Roberts conducts a one-week earth science field trip with the students camping enroute. This activity has had strong student and parent support. Evening sessions in astronomy at the school and at his home are commonplace throughout the school year.

In recognizing Dr. Frank Roberts for this award, the Eastern Section of the National Association of Geology Teachers recognizes a truly outstanding teacher, a man who was one of the first to introduce earth science into the secondary schools and a man who is today an inspiration to his school and community.

OMISSION FROM "NATIVE SULFUR IN PENNSYLVANIA"

In the January-February issue of "Pennsylvania Geology" (Vol. 2/1(there was an omission in the article on native sulfur (p. 14-15). It was stated that sulfur is more abundant than calcium. Actually, in the crust of the earth sulfur is more than 200 times *less* abundant than calcium. It is only on the scale of cosmic element abundance that sulfur exceeds calcium.

This omission was noted by Professor Greenwood of Rutgers University, Camden, N.J. We are pleased that our bulletin is receiving widespread attention and invite all our readers to send in their comments and suggestions for future articles.

SURVEY ANNOUNCEMENTS

STOP ABUSING COLLECTING SITES

Mineral and fossil collecting are widespread and fascinating hobbies, but collectors are abusing their privileges. During the past year, we have received complaints about mineral collectors from eight different property owners. Undoubtedly there are others that have not been reported to us. Two problems are involved in this abuse: personal safety and property destruction. At one location a collector was stunned by a rock-fall from a quarry wall and at another a collector was nearly buried alive by the caving of a hole dug in the search for quartz crystals. At one location, collecting has been restricted to weekends because of interference with quarrying operations. At still another, a collector was almost burned to death when the ground collapsed near his feet into a gaping hole of burning anthracite. DO NOT COLLECT WHERE DANGERS EXIST. WEAR SAFETY HELMETS, GLASSES, AND BOOTS. OBTAIN PERMISSION.

Trespassing and property damage is widespread. It must be stopped! Grass and flower beds have been ruined. Banks along roads have been undercut resulting not only in disfigurement but in danger to vehicular traffic. At one locality greedy collectors permanently defaced the land by digging dozens of huge holes like some monstrous prairie dog in their search for crystals. At another, a dealer removed a truck-load of material without permission, raping the area of any future value to collectors.

The future of collecting, if there is to be any at all, is in your hands. You must act responsibly for the sake of yourselves and property owners.

The following locations are now closed to collectors:

Stillwell Quarry, Lancaster County
Kunkletown Quarry, Monroe County
Grace Mine, Morgantown, Berks County

In addition, collectors at Reeser's Summit are warned not to park on private property, not to undercut banks, not to destroy vegetation; in short, DO NOT TRESPASS. Remember, other people have rights too: ALWAYS ASK PERMISSION AND CONDUCT YOURSELVES RESPONSIBLY.

D. M. Lapham

HIDDEN VALLEY REPORT PUBLISHED

The Pennsylvania Geological Survey has recently published General Geology Report G-30, "The Geology of the Hidden Valley Boy Scout Camp Area, Perry County, Pennsylvania", by John T. Miller and Richard B. Wells.

This report includes an introduction to geology, a description of the stratigraphy, structural geology, and geologic history of the area, and information on sources of geologic information for those scouts who wish to pursue the subject further. Sedimentary rock formations of Silurian age (400 to 440 million years old) are present in the camp area, including the Tuscarora, Rose Hill, Keefer, Mifflintown, Bloomsburg, Wills Creek, and Tonoloway Formations. A block diagram of the area shows how these sandstone, shale, and limestone beds have been folded into an anticlinal structure and broken by faulting.

The new report is an up-dated and expanded version of a 1957 report on the same area. Since the first edition was published, the camp has doubled in size, and numerous new trails, buildings, and facilities have been added. The report contains separate geologic and topographic maps, as fold-outs, on which are marked the locations of some 37 important bedrock outcrops in and around the camp. Geologic descriptions of each outcrop are included in the Appendix, so that a boy scout, using the maps and a compass can conduct his own geologic "field trip" of the camp area.

General Geology Report G-30 may be purchased for $0.50 plus $0.03 tax from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pennsylvania 17125.

NEW CLARION RIVER BASIN WATER STUDY

A study of the water resources of the Clarion River and Redbank Creek drainage basins has been initiated. The study will be conducted as a cooperative project of the Bureau of Topographic and Geologic Survey, and the Bureau of Engineering, of the Department of Environmental Resources, and the United States Geological Survey.

The project area is 1,828 square miles and is composed of parts of Clarion, Elk, Jefferson, Forest, McKean, Armstrong, and Clearfield Counties. Full scale field operations for the project will begin in July 1971 and will continue for at least four years. However, the first phase of the study, which is a compilation of existing ground-water information in Clarion County, is nearing completion and will soon be published by the Bureau of Topographic and Geologic Survey.

Residents of the Clarion River and Redbank Creek basins have expressed concern over deterioration of their water supplies. Water will be collected to determine the volumes of stream flows and the variations in those flows. Data will also be collected to determine the yields that can be expected from wells tapping the various geologic formations in the area and the effects of topography, structure, and well-completion techniques on the yields of wells. Chemical analyses will be made of water from streams and selected wells to

determine whether the undesirable characteristics that have contributed to the deterioration of the water supplies are due to natural influences or to the influence of man's activities. Such information will provide a foundation on which future decisions can be made in regard to development of the water-resources of the area. The results of the Clarion River and Redbank Creek basin studies will be made available to the public through publication by the Department of Environmental Resources.

WILLIAMSPORT AREA STUDY BEGINS

This past March, the Pennsylvania Geological Survey initiated a new project of areal geologic mapping in the Williamsport area. This mapping project is the initial stage of a more extensive program of evaluating mineral and economic potentials, environmental geologic factors relevant in an urban area and a study of the ground-water resources. The geologic mapping supplies the basic information needed in these other studies. The Williamsport area was selected because it is a large growing urban area in central Pennsylvania, and because little geologic mapping has been done in the area since the 1880's. Thus a definite need of detailed geologic information exists for planning and urban growth.

The initial phase of geologic mapping extends from Jersey Shore on the west to Williamsport on the east, and from Nippenose Valley on the south to the Allegheny Plateau on the north. This area is encompassed by four 7½-minute quadrangles - Linden, Salladasburg, Williamsport and Cogan Station. The mapping is being done by staff geologists Rodger T. Faill and Richard B. Wells. It is anticipated that geologic maps for this area will be completed by the end of 1972. It is expected that mapping will subsequently be continued to the east and south, generally following the course of the Susquehanna River Valley.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All cost publications are available at the Pennsylvania Bureau of Publications, P.O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax. For free publications write to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

Publication		*Price*
ES3	**Ground** water **in Pennsylvania** by A. E. Becher, (42 p., 29 2 color figs., 1 full color map)	Free
G30	(2nd Ed.) **The geology of the Hidden Valley Boy Scout Camp Area, Perry County, Pa.** by J. T. Miller and R. B. Wells, (45 p., 11 figs., 2 plates)	$0.50
W 26	**Hydrogeology of the carbonate rocks of the Lancaster 15' quadrangle, southeastern Pennsylvania** by Harold Meisler and A. E. Becher (121 p.), 25 figs., 2 plates	$5.90

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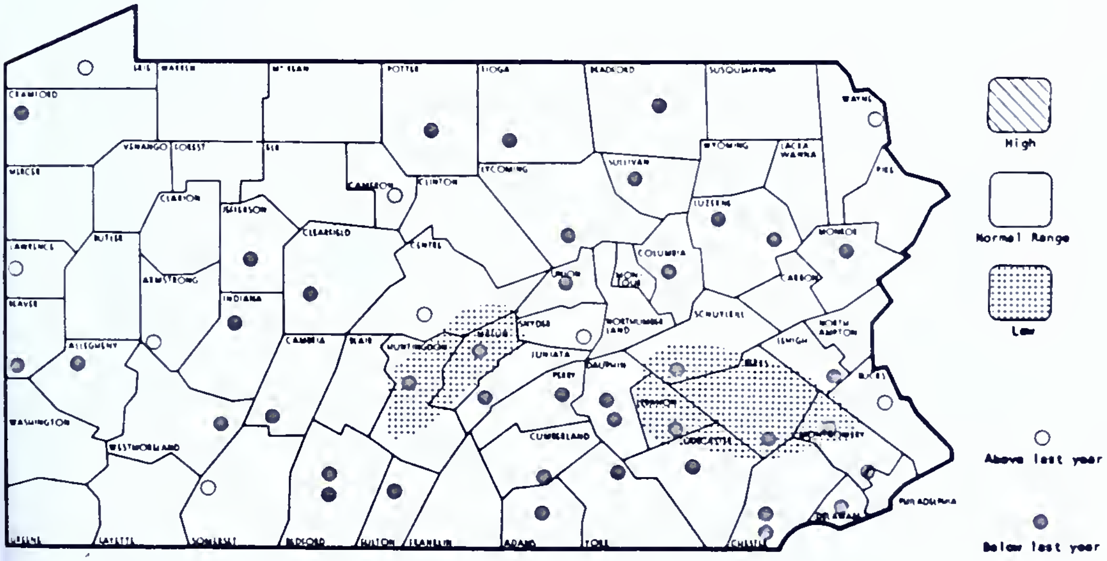

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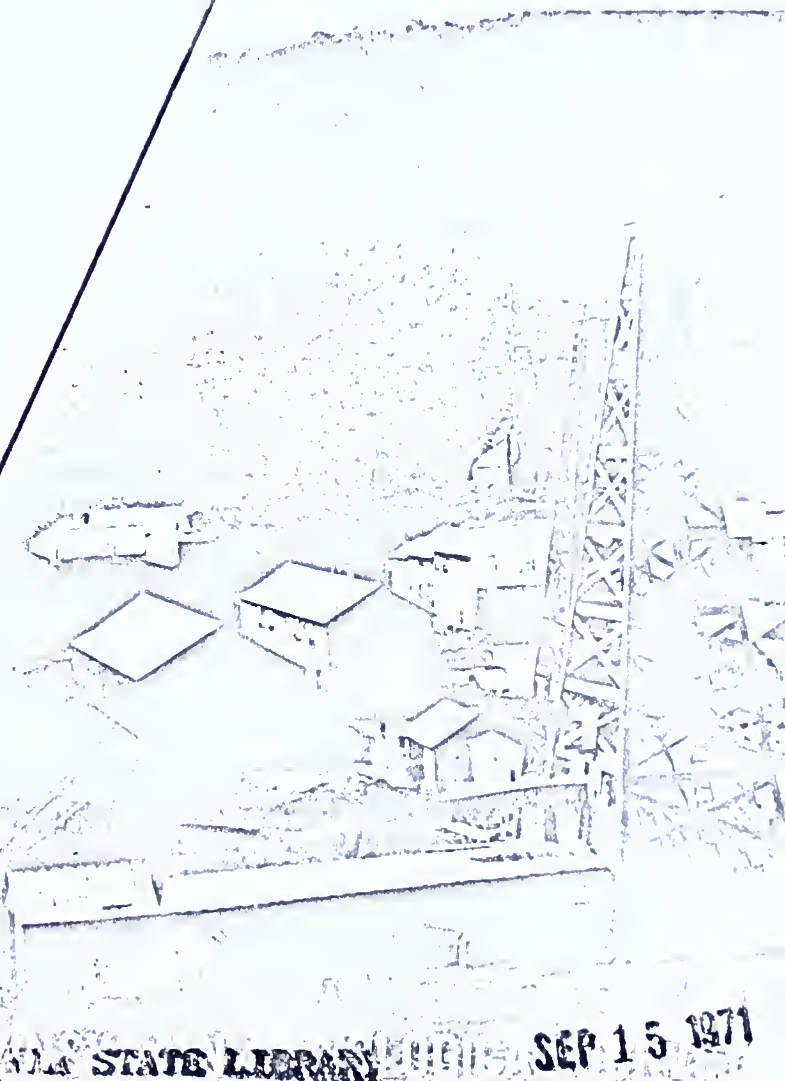

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DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER – The Bradford oil field in the late 1800's. (Photo courtesy of the Drake Well Museum)

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

AUGUST 1971

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

BRADFORD FIELD, SYMBOL OF RESEARCH DONE, AND WAITING TO BE DONE

The Topographic and Geologic Survey is pleased to join in commemorating the Centennial of the discovery of the great Bradford Oil Field. This outstanding oil field in northwestern Pennsylvania has proved itself to be one of the greatest mineral concentrations in the country. The Bradford Field is a unique occurrence and geologists can be proud that the development and interpretation of geologic data in the field was in large measure responsible for the success in developing primary production, and later secondary production.

It is a happy coincidence that the Bradford Field Centennial takes place in the month when this bulletin features the annual review of geologic research in Pennsylvania. Bradford is not a historical relic of the past. It is an established, producing oil field which symbolizes a two-fold challenge to geologic research. First is the challenge to locate new oil and gas concentrates, particularly in the deep, thick stratigraphic sections in Pennsylvania still largely untested. Secondly, is the challenge to improve our oil recovery techniques. Bradford truly epitomizes the struggle to get the oil out of the ground once the oil concentrate has been discovered. The fact is that at Bradford, as at most other fields, existing recovery techniques still leave more than half of the oil concentration unrecovered in the ground.

A frequent definition of conservation is "wise use". Our inability to extract known oil in the ground is truly non-conservational. As we recognize both research and the Bradford Field in this issue, we hope there will be a serious effort to bring the two together, so that through research, newer and better Bradford Fields will result.

Arthur A. Socolow

GEOLOGICAL RESEARCH IN PENNSYLVANIA

1971

INTRODUCTION

The fifteenth annual report of Geological Research in Pennsylvania has been compiled by the Pennsylvania Geological Survey as a service to all individuals interested in geological research in Pennsylvania.

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Project descriptions are printed where authors supplied us with such descriptions. Publications printed since April 1970 are listed alphabetically. Publications in press are listed similarly.

As with all compilations, there may have been omissions. If you know of anyone who would be interested in receiving this annual report, send us their name so that it can be included on our mailing list. Additional copies can be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, Pa. 17120.

RESEARCH IN PROGRESS

AREAL GEOLOGY

HAROLD H. ARNDT, U.S. Geological Survey. Western Middle Anthracite Field. Final report nearing completion.

THOMAS M. BERG, Pennsylvania Geological Survey. Geology of the Brodheadsville 7½-Minute Quadrangle. Field work is complete.

MARION J. BERGIN, U.S. Geological Survey. Northern Anthracite field. Mapping in the Nanticoke and Shickshinny 7½-minute quadrangles continues. Data is being compiled for the Kingston, Pittston, and Wilkes-Barre East and West 7½-minute quadrangles.

AVERY A. DRAKE, JR., U.S. Geological Survey. Geology of Allentown Quadrangle. Objectives: To decipher the tectonic history of the area with special emphasis on the emplacement of gravity slides, Alpine nappes, and thrust sheets. Field work in the Hellertown and Allentown-East quadrangles is completed. Most of the Catasauqua 7½-minute quadrangle is complete.

JACK B. EPSTEIN, U.S. Geological Survey. Geology and Mineral Resources of the Wind Gap and Adjacent Quadrangles. Mapping continues in the Wind Gap, Stroudsburg, and Saylorsburg quadrangles. Ordovician to Middle Devonian rocks in parts of Lehighton, Palmerton, and Kunkletown quadrangles were mapped in cooperation with W. D. Sevon and J. D. Glaeser of the Pennsylvania Geological Survey in the Valley and Ridge province of eastern Pennsylvania, including the inter-relationship of stratigraphy, sedimentation, structure, geomorphology, glacial geology, and economic geology of Middle Ordovician through Middle Devonian strata and overlying surficial deposits in the area between the Delaware and Lehigh Rivers.
Subjects investigated are sedimentation and stratigraphy of Silurian and Lower Devonian fluviatile, infratidal, and deep neritic clastic and carbonate rocks including study of polished slabs, acetate peels, thin sections, heavy minerals, and clay-size fraction using X-ray diffraction techniques; interpretation of Illinoian (?) glacial history and recognition of Wisconsin sequential deglaciation; recognition of lithotectonic units separated by decollements and the recognition of Taconic and "Appalachian" structural features; investigation of the origin of cleavage; investigation of economic resources including residual clays, sand and gravel, slate, and building stone; investigation of structural control of wind and water gaps in the Folded Appalachians of eastern Pennsylvania; relationship between "Hamburg klippe" and slate belt of eastern Pennsylvania (with A. A. Drake, Jr.).

RODGER T. FAILL and RICHARD B. WELLS, Pennsylvania Geological Survey. Geology of the Williamsport 15-Minute Quadrangle. Areal mapping, stratigraphic description and structural analysis of the geology in the Williamsport 15-minute quadrangle, with a brief discussion of economic resources and engineering properties of the rocks.

GARY B. GLASS and WILLIAM E. EDMUNDS, Pennsylvania Geological Survey. Geology of the Southern Houtzdale and Ramey 7½-Minute Quadrangles.

WILLIAM A. BRAGONIER, Pennsylvania Geological Survey, Mercer High Alumina Genesis. Genesis, geologic distribution and prediction of the high alumnia clay, which is one of Pennsylvania's most valuable non-metallic minerals. Prospecting is currently being carried on without an adequate model. This project hopes to define a basis for economic prediction.

WILLIAM E. EDMUNDS, Pennsylvania Geological Survey. Compilation of County Bituminous Coal Reserves and Compilation of Strippable Bituminous Coal Reserves.

JACOB FREEDMAN, Franklin and Marshall College. Geochemical Prospecting for Base Metals on Mine Ridge, Southeastern Pennsylvania. Beginnings were made in collecting soil samples and doing magnetic surveys on the ground at sample sites with prospecting for nickel and copper. A few samples have been analyzed but so far the geochemical analyses do not corroborate local magnetic anomalies.

KARL V. HOOVER, Pennsylvania Geological Survey. Atlas of Pennsylvania Mineral Resources: Part 2 - Clays and Shales. Compilation of all geologic information of Pennsylvania's clays and shales. The publication will be a collection of geologic maps, physical property and ceramic list data, chemical analyses, and summary tables of established and potential uses.

KARL V. HOOVER, Pennsylvania Geological Survey in cooperation with the U.S. Geological Survey. Clay-Shale Resources of the Pittsburgh Trade Area. Field and laboratory evaluation of the clay and shale deposits in southwestern Pennsylvania.

KARL V. HOOVER, Pennsylvania Geological Survey. Data Collection for Continuous Up-dating of the Mineral Industry Directory of Pennsylvania.

JOHN W. HOSTERMAN, U.S. Geological Survey. Northern Appalachian Clay Mineral Studies. Objectives are to study the mineralogy and chemical and physical properties of the clay deposits in Pennsylvania including residual white clay deposits in Monroe, Cumberland, Centre and Blair counties and the metamorphosed underclays of northeastern Pennsylvania and the kaolinitic underclays of Somerset and Fayette counties. A report of the clay resources of Somerset and Fayette counties is nearing completion.

DANA R. KELLEY and ROBERT C. FENTON, Pennsylvania Geological Survey. Subsurface Reservoir Core Analyses. Compilation of core analysis data into tabulations and graphs illustrating porosity, permeability, saturation, density, salinity, and other core data relationships by unit; temporarily suspended, to be reinitiated during the year.

DANA R. KELLY and WALTER R. WAGNER, Pennsylvania Geological Survey. Surface to Middle Devonian (Onondaga) Economic Stratigraphy of Western Pennsylvania. To erect a stratigraphic framework for Upper Devonian, Mississippian and Pottsville (Pennsylvanian) rocks of western Pennsylvania. The work is to be completed in three phases. Phase I, showing major subdivisions of Upper Devonian Rocks, is published (Pa. Geol. Survey PR 178). Phase II, partly completed and in press, consists of a network of cross sections tying subsurface data (geophysical well logs) into surface sections. The sections will show hydrocarbon reservoirs, gross stratigraphic changes, and position of fresh water, coal, limestone, clay and other major resources. Phase III - regional interpretation of Phase II employing isopach and lithofacies maps have not yet been started.

WILLIAM S. LYTLE, Pennsylvania Geological Survey. Crude Oil Reserves of Pennsylvania. To bring Survey publication M-32 "Crude Oil Reserves of Pennsylvania" up to date using chemical logs and core reports that were not available when M-32 was written. Considerable additional information is now available which will give more meaning to the reserve estimate.

WILLIAM S. LYTLE, DANA R. KELLEY, WALTER R. WAGNER, and LOUIS HEYMAN, Pennsylvania Geological Survey. Oil and Gas Developments in Pennsylvania in 1971. A description of the developments during 1971 in search of oil and gas, including highlights, statistics, and general oil and gas data.

JAMES P. MINARD, U.S. Geological Survey. Southeast Appalachian Sediments. Investigations of potential mineral deposits, especially heavy metals, in the Atlantic Coastal Plain and eastern Triassic basins.

ENGINEERING GEOLOGY

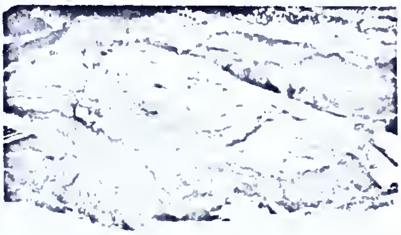
NORMAN K. FLINT, University of Pittsburgh. Slope Stability Study on Interstate 79 Northwest of Pittsburgh. A combined soil mechanics - geological study of colluvial masses in the Pittsburgh Redbeds (Conemaugh) along a section of Interstate 79 in Ross and Ohio Townships, Allegheny County. Shear zone materials from ancient landslide masses are being sampled and tested for strength properties and clay mineral composition. An excavated slope in the Redbeds will

be instrumented to monitor any movement that occurs. The overall purpose of this study is to obtain information that will be useful in highway design, and in lowering the cost of highway construction.

RICHARD M. FOOSE, Amherst College. Sanitary Landfill Developments in Derry Township, Pennsylvania. Geologic mapping and diamond and rotary drilling provide the basis for evaluating a site for sanitary landfill developing in the Martinsburg shale. Major geologic parameters are depth to ground water, ground water movement, the control of structural elements in the shale on ground water movement and trench development, and the ability of the shale to remove leachate by ion exchange and absorption.

KARL V. HOOVER, Pennsylvania Geological Survey, RICHARD HOWE and DAVID REIDENOUR, Pennsylvania Department of Transportation, Engineering Properties of Shales for Highway Granular Material Use. Investigations of engineering properties of shales for use as a granular material for highway construction. A major endeavor of the project is to establish testing standards for selecting suitable shales.

ENVIRONMENTAL GEOLOGY



R. P. BRIGGS, U.S. Geological Survey. Pittsburgh Regional Environmental Geology Study. Cooperative project between the Pennsylvania Geological Survey and the U.S. Geological Survey to produce a series of maps and reports on the Greater Pittsburgh urban area that will relate physical and environmental and resource features in a manner meaningful and useful to regional planners and developers without further interpretation or a minimum amount of interpretation.

ALAN R. GEYER and WILLIAM G. McGLADE, Pennsylvania Geological Survey. Environmental Geology for Land-Use Planning. Guide to the value of geology in all phases of land-use planning, design, and construction.

MARY E. HORNE, Pennsylvania Geological Survey. Environmental Geology of the Greater York Area. This study involves the incorporation of basic geologic mapping with soils mapping, ground water data, mineral resource data, and engineering characteristics of rock formations with the application of these data to present land use in the area and to projected growth needs.

DANA R. KELLEY, Pennsylvania Geological Survey. Clay-shale Related Landslides in the Pittsburgh, Pennsylvania Area. As a means of informing industry, government, and the public of the serious landslide hazards existing in and about Pittsburgh, a short compilation of existing knowledge and causes of these slides is being prepared, including a map of slides of record, general cross sections illustrating stratigraphic variation in hazardous zones and selected illustrations, diagrams, and graphs.

WILLIAM G. McGLADE, Pennsylvania Geological Survey. Environmental Geology of the Harrisburg Metropolitan Area. Compile, reinterpret and add basic geology, ground water, mineral resource and engineering data for the Harrisburg Metropolitan area. The purpose of this study is to apply geological principles, and interpretations toward an understanding of the subject area that will be immediately useful to planners, engineers, government officials, and the general public.

GENERAL GEOLOGY

SANDRA D. BLUST, Pennsylvania Geological Survey. Compilation of Theses from Pennsylvania Colleges Pertaining to Pennsylvania Geology.

ALAN R. GEYER, Pennsylvania Geological Survey. A Geologic Guide to Rickett's Glen State Park, A geologic description of Rickett's Glen State Park with special emphasis on the origin of the waterfalls.

DAVIS M. LAPHAM and ALAN R. GEYER, Pennsylvania Geological Survey. Common Rocks and Minerals of Pennsylvania. A complete rewrite of the Survey's Education Series No. 1 booklet.

WILLIAM S. LYTLE and LILLIAN HEEREN, Pennsylvania Geological Survey. Principal Crude Oil, Product and Natural Gas Pipelines. Brings the pipelines map up to date showing changes, refineries and gas storage fields.

GEOCHEMISTRY

DAVIS M. LAPHAM, Pennsylvania Geological Survey. Isotopic Dating of Precambrian Schists, Erie County. Correlation and significance of K-Ar and Rb-Sr age dates on Precambrian metasediments from drill cores beneath the Plateau.

DAVIS M. LAPHAM and SAMUEL ROOT, Pennsylvania Geological Survey. A Compendium of All Radiometric Dates in Pennsylvania Through 1969 and Their Regional Significance.

DAVIS M. LAPHAM and SAMUEL ROOT, Pennsylvania Geological Survey. Isotopic Dating in the Blue Ridge of Pennsylvania. Correlation and significance of U-Pb, K-Ar, and Rb-Sr dates in the Pennsylvania Blue Ridge.

DAVIS M. LAPHAM and SAMUEL ROOT, Pennsylvania Geological Survey. Isotopic Dating of Faulting in the Great Valley of Pennsylvania. Significance of K-Ar dates on fault gouge and enclosing sediments in the Pennsylvania Great Valley.

DAVIS M. LAPHAM, SAMUEL ROOT, and DAVID MacLACHLAN, Pennsylvania Geological Survey. Isotopic Dating in the Reading Prong of Pennsylvania. Correlation and Significance of K-Ar dates in the Pennsylvania Reading Prong.

E-AN ZEN, U.S. Geological Survey. Low Temperature Mineral Equilibria. A study of the geologic history, stratigraphy, and metamorphism of the western part of the northern Appalachian orogeny especially the evolution of the Taconic allochthon and its analogs from Newfoundland to Pennsylvania.

GEOMORPHOLOGY

DONALD R. COATES, State University of New York at Binghamton. Quantitative Geomorphology of the Appalachian Plateau in Pennsylvania and New York. This study covers much of New York State and the Appalachian Plateau in Pennsylvania. The quantitative aspects of the Plateau and a comparison of the glaciated and non-glaciated parts are emphasized. The morphometry of drainage systems are analyzed and some of the hydrogeology aspects of selected rivers are compared.

SAMUEL HARRISON, ERIC REDDING and MARGE CHAKLOS, Allegheny College, Suspended Sediment in Mercer Pike Stream. A study of erosion from highway construction sites.

SAMUEL HARRISON and JOHN CLENDENING, Allegheny College. Increase of Suspended Sediment in Woodcock Creek as a Result of Dam Construction Activities. Meadville, Pennsylvania.

SAMUEL HARRISON and RICHARD KORNBRATH, Allegheny College. Frost Disintegration of Exposed Soils, Meadville, Crawford County.

STEVE KOWALL, State University of New York at Binghamton, Geomorphology and Hydrogeology Comparison of Basins in the Folded and Non-folded Appalachians of Pennsylvania. Geomorphic features of several basins in the Appalachian Plateau and the Folded Appalachian Mountains were mapped. Automatic recording stream gaging stations were installed in three basins. One purpose of the study was to determine if important differences occurred in the two provinces in stream regimes. Low flow was emphasized. Periglacial processes have produced features that influence streamflow characteristics.

RICHARD A. MARTIN, Millersville State College. Geology of Devil's Racecourse, Boulder field, Dauphin County, Pennsylvania. An investigation of the source of boulders, mechanism for movement, and present-day changes in the boulder field.

HOWARD A. MEYERHOFF, Tulsa, Oklahoma. Post-orogenic development of the Appalachian Folded Mountains and Piedmont. Analysis of Appalachian and Triassic structures from the Delaware River to Williamsport and Lock Haven with specific relation to post-orogenic fluvial history.

GEOPHYSICS

CHARLES E. CURTIS, Aero Service Corporation, Philadelphia. Appalachian Basin Aeromagnetic Survey of Pennsylvania and Ohio. In 1960 and 1961, Aero Service Corporation of Philadelphia, Pennsylvania performed an airborne magnetometer survey covering nearly 150,000 square miles of the central Appalachian basin as a speculative venture. The instrument used was a Gulf R&D fluxgate magnetometer, which recorded the observed variations in the earth's total magnetic field in analog form. The data were subsequently compiled in the form of isomagnetic contour maps.

During the past year an interpretation of the survey coverage in western Pennsylvania and eastern Ohio was performed which involved the digitization of the existing analog recordings and a computer analysis to determine the configura-

tion and depth of the geologic sources causing the anomalous magnetic variations. The majority of these sources were found to occur within the basement complex, and the net result of the study is a structure contour map of the Precambrian surface.

The study presents a number of interesting implications regarding relationships between Precambrian structures and deformation in the region. A considerable amount of evidence exists in support of some of the theories of previous investigators, such as the "Waverly Arch" and the "Lower Cambrian Coastal Declivity" proposed by Woodward (1961), and the presence of extensive northwest-trending lineaments in the Plateau province suggested by Gwinn (1964).

In the main, the magnetic evidence suggests little if any widespread direct involvement of the basement in Appalachian folding. However, there appears to be a strong possibility that the mechanisms of folding are related to ancient erosional and structural irregularities on the basement floor.

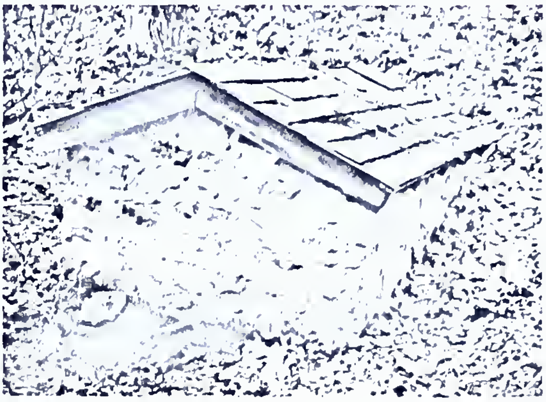
GLACIAL GEOLOGY

DONALD R. COATES, State University of New York at Binghamton. Mastodon Bone Age and Geomorphic Relations in the Susquehanna Valley, Bradford County and Chemung County, Pennsylvania and New York. Two radiocarbon ages provide a stratigraphic framework for some events in the Susquehanna Valley. A 13,320 + 200 years before present date on a mastodon pelvic fragment from outwash gravels aids in refining Valley Heads substage in central New York. A 1,690 + 100 years before present date on wood provides an age for the first preserved flood plain deposits.

G. GORDON CONNALLY, SUNY at Buffalo and JACK B. EPSTEIN, U.S. Geological Survey. Glacial Geology of the Saylorsburg Quadrangle. The glacial geology and Pleistocene stratigraphy of the Saylorsburg Quadrangle reveal at least five recessional sequences north of the "Terminal Moraine." Three of these sequences are related to Glacial Lake Sciota. At least one pre-Terminal Moraine, Wisconsinan till has been mapped as well as "Illinoian" till. As many as five distinct tills probably exist in the area. The tills will be the subject of a forthcoming review paper by Connally and Epstein. The quadrangle will be published as an USGS GQ.

GEORGE H. CROWL, Ohio Wesleyan University. Re-examination of the Terminal Moraine in Luzerne County.

HYDROLOGY



ALBERT E. BECHER and WALTER S. WETTERHALL, U.S. Geological Survey. Urban and Rural Ground Water Hydrology in the Northern Part of the Cumberland Valley, Pennsylvania. Knowledge of the hydrology is important for the efficient development and protection of the water resources in the Cumberland Valley to support the rapid growth now occurring and that will occur in the future. This project will define the limits and the yielding capability of the carbonate aquifers and the Martinsburg shale, determine well site criteria, describe how the aquifers function within the hydrologic system and evaluate the effects of urbanization on water quality.

RICHARD BOWER, West Virginia University. The Effects of Produced Brines from Oil Field Operations on Ground Water and Surface Water Quality in Parts of the Middle Bedford Oil Producing Districts in Pennsylvania.

ROSS D. BROWER, University of Illinois. Environmental Factors Influencing the Variability of Stream Flow in Selected Basins in the Susquehanna and Delaware River Basins. Quantification of various terrestrial, climatic, and land use factors and evaluations of their effect on the character of stream flow of a selected group of small basins has shown that geology (rock type and to some extent structure) most strongly controls among basin variability and climate most strongly produces within basin variability. Changes in land use practices may have a minor effect on within basin variability. Observable variability in stream flow data among and within basins can be explained with a reasonable degree of accuracy.

BARBARA U. CONRAD, PAUL A. CLOUSER, and ALAN R. GEYER, Pennsylvania Geological Survey. Coding, key punching, and computer storage and retrieval of all water wells drilled in Pennsylvania since May, 1966. This will be a continuing project.

ROBERT C. FREAS, U.S. Department of Agriculture, Ground Water Resources of the Fairfield Quadrangle, Adams County, Pennsylvania.

MARILYN GINSBERG, State University of New York at Binghamton. Hydrogeology of the Triassic Basin in Pennsylvania. This study evaluates the hydrogeologic characteristics of the Triassic Basin. Several hundred wells are compared in such terms as yield and specific capacity, and an evaluation is made of factors that control their production. Precipitation and stream hydrology records are indexed and analyzed in relation to geomorphic features of the region.

JERRALD R. HOLLOWELL and HARRY E. KOESTER, U.S. Geological Survey. Ground Water Resources of Lackawanna County. Project is to evaluate and appraise the ground water resources in the county.

ORVILLE B. LLOYD, JR. and DOUGLAS J. GROWITZ, U.S. Geological Survey. Ground Water Resources of Central and Southern York County. The investigation will evaluate the water-bearing and water-quality characteristics of the major bedrock units in the area of study.

JOHN J. MURPHY, U.S. Geological Survey, PAGE FIELDING, Delaware River Basin Commission, and HAIG KASABACH, New Jersey Department of Environmental Protection. Occurrence, Distribution, and Relationship of Contaminants in the Potomac Raritan Magothy Aquifer in Philadelphia County, Pennsylvania and Gloucester County, New Jersey. Industrial and landfill pollutants have entered the lower aquifer of the Potomac-Raritan-Magothy formation in southeast Pennsylvania. Increased pumping from this aquifer in New Jersey has altered the hydraulic gradient, and the pollution is moving in the direction of pumpage. The quality and utility of the aquifer water is thereby threatened. This aquifer is a significant segment of the coastal plain aquifers of New Jersey which comprise the major water resources of southern New Jersey.

THOMAS G. NEWPORT and JOHN GALLAHER, U.S. Geological Survey. Summary reports of the ground-water resources of each county in Pennsylvania.

RICHARD C. RHINDRESS, Department of Environmental Resources. Hydrology and Water Quality of Public Ground-Water Supplies. Ninety-five percent of the public water supply companies using ground water sources have been inventoried for hydrology and water quality characteristics of the producing aquifers. This data is now ready for computer analysis, and public use. Computer prints of data will be available in late summer.

CHARLES R. WOOD, U.S. Geological Survey. Geology and Hydrology in Northern Berks County.

IGNEOUS AND METAMORPHIC GEOLOGY

AVERY A. DRAKE, JR., U.S. Geological Survey. Chemistry of the Precambrian Rocks of the Reading Prong of Pennsylvania, New Jersey and New York. In addition, the radiogenic heat producing minerals on these rocks will be studied, hopefully to gain greater insight into heat flow in this complex tectonic terrane.

FRANK H. ROBERTS and WILLIAM A. CRAWFORD, Bryn Mawr College. Retrograde Metamorphism of Ultra Mafic Rocks in Southeastern Pennsylvania.

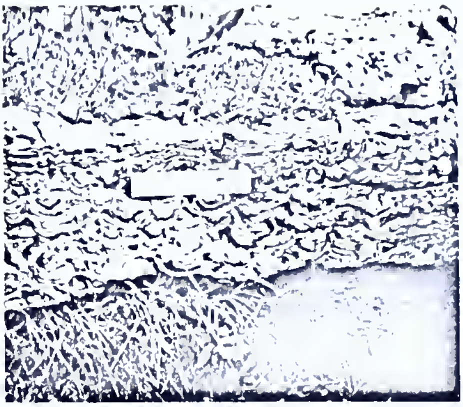
MINERALOGY

DAVIS M. LAPHAM and JOHN BARNES, Pennsylvania Geological Survey, and WAYNE DOWNEY, Bishop McDevitt High School. Mineralogy Associated with the Burning Anthracite at Kehley's Run Mine, Schuylkill County, Pennsylvania.

DAVIS M. LAPHAM and ALAN R. GEYER, Pennsylvania Geological Survey and DONALD HOFF, Wm. Penn Memorial Museum. Mineral Collecting in Pennsylvania. A continuing project to describe minerals and mineral localities in Pennsylvania.

ARTHUR MONTGOMERY and RAYMOND W. GRANT, Lafayette College. Mineralogy of Pennsylvania. This project continues with the monthly publication of a column "Pennsylvania Minerals" in the Keystone Newsletter of the Mineralogical Society of Pennsylvania.

PALEONTOLOGY



JOHN H. BARWIS, Temple University. Oriskany Formation Paleoenvironments Between Palmerton and Stroudsburg.

J. P. DUTRO, JR., U.S. Geological Survey. Paleozoic Brachiopoda. Taxonomic and biostratigraphic studies of Paleozoic brachiopods including special emphasis on the Middle Devonian of the eastern and central United States.

CAROL FAUL, University of Pennsylvania. Study of the Pohopoco Fauna, Mahantango Formation, Carbon County, Pennsylvania.

DONALD HOFF, Pennsylvania Historical and Museum Commission. Vertebrate Paleontology of York County. Salvage of vertebrate fossils from the Triassic New Oxford Formation in York County, Pennsylvania. Considerable phytosaur and metoposaur material has been recovered. In addition to the removal of skeletal parts of the rare stereospondyl amphibian, *Eupelor durus,* a new vertebrate paleontological quarrying technique has been perfected.

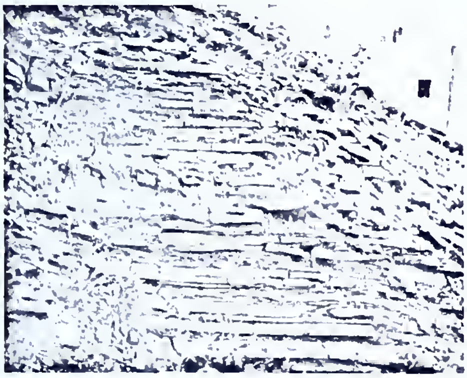
ROBERT B. NEUMAN, U.S. Geological Survey. Ordovician Brachiopods and Stratigraphy of Eastern United States. Field study and collection of fossils in the Martinsburg shale area of eastern Pennsylvania is under progress.

RICHARD WHITE, JR. and HORACE G. RICHARDS, Academy of Natural Sciences, Philadelphia. Restudy of Pleistocene Vertebrates from Cave at Port Kennedy, Pennsylvania.

SEDIMENTARY PETROLOGY

WILLIAM R. KAISER, Johns Hopkins University. Cyclic Sedimentation in the Middle Devonian of South-Central Pennsylvania. A*sedimentological and rock stratigraphic study of the Montebello member of the Mahantango Formation Well-developed, coarsening-upward cycles characterize the Montebello. It is probably the finest ancient example of this type of sedimentation in the central Appalachians. Cycles are regarded as progradational sequences analogous to those described from holocene delta fronts. Cyclicity is believed to represent the initiation, growth and abandonment of several delta lobes.

ROGER G. WALKER, McMaster University, Canada. Catskill Delta Sedimentation in Southeastern Pennsylvania.



STRATIGRAPHY

ERNST CLOOS, Johns Hopkins University. Geology of the Thomasville Area, York County, Pennsylvania. A study of the Thomasville Pennsylvania limestone area and adjacent Triassic. Detailed stratigraphy of the Kinzers formation, its economic development and exploitation. Limestone chemistry and formation of subunits. Recently exploration included the Triassic overlap at Thomasville and drilling shows an unsuspected limestone conglomerate and cyclic sedimentation over 750 feet thick.

W. E. EDMUNDS, A. D. GLOVER, G. B. GLASS and W. A. BRAGONIER, Pennsylvania Geological Survey. Project TASIC. This project (Temporarily Available Stratigraphic Information Collection) is a continuing program involved with the recovery of stratigraphic data from active coal and clay strip mines and construction sites, while exposures are available. This long-term project is designed to provide data for future mapping and regional mineral resource evaluation. This information will also be useful in establishing the stratigraphic framework of coal-bearing rocks in western Pennsylvania, in making reserve calculations, in coal and coal land evaluation, in ground-water aquifer potential, in excavation and foundation information and in clay, shale, and other resource exploration.

RICHARD W. FAAS, Lafayette College. Triassic Border Fault Relationships in the Gettysburg Basin. Project continues to analyse subtle stratigraphic relationships relating to the sedimentation and depositional environments along the northern border of the Gettysburg basin.

J. DOUGLAS GLAESER, Pennsylvania Geological Survey. Correlation and Environmental Interpretation of Upper Devonian Rocks in Northeastern Pennsylvania. Regional study of surface and subsurface Upper Devonian sections in terms of depositional origin of correlatable stratigraphic units. Hydrocarbon, flagstone, and artesian water distributions are controlled by sedimentological character of the associated stratigraphic units.

J. DOUGLAS GLAESER, Pennsylvania Geological Survey. Comparison of Triassic sediments with those of the Salton Trough, California.

LOUIS HEYMAN, Pennsylvania Geological Survey. Subsurface Correlation Sections, Tully (M. Devon.) – Queenston (U. Ord.). Establish stratigraphic framework for subsurface sedimentary petrology studies of various producing and potential oil and gas reserviors in this part of the geologic section. These reservior rocks are also potential waste disposal zones. Other zones of potential value (brine production, evaporites) will be indicated.

D. M. HOSKINS, R. T. FAILL, and R. WELLS, Pennsylvania Geological Survey. Study of Middle Devonian stratigraphy in Central Pennsylvania.

BION H. KENT and JOHN B. ROEN, U.S. Geological Survey. Geology of the Mather-Garards Fort Area, Southwestern Pennsylvania. Work in progress concerns summary reports on the stratigraphic nomenclature, facies changes and lithofacies trends of bedrock in the northern half of the Dunkard coal basin and their effects upon associated coal beds. Current research work also concerns the influence of structure on the thickness and composition (ash and sulfur content) of subsurface coal beds.

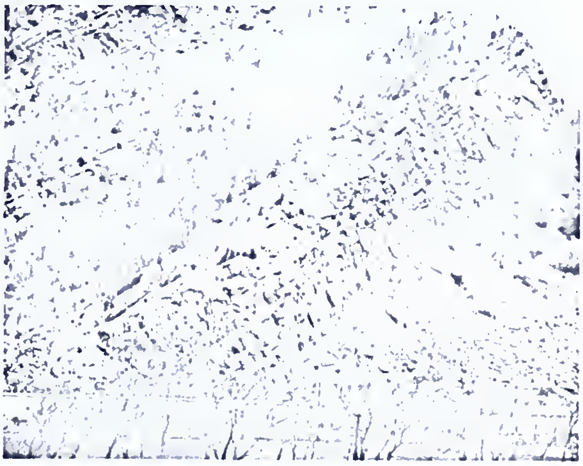
DAVIS M. LAPHAM, JOHN BARNES, and RODGER FAILL, Pennsylvania Geological Survey. Description of Rock Units, Alteration Processes, and Structure at the Triassic-Paleozoic North Margin Contact at Highspire, Pennsylvania.

LUCIAN B. PLATT, Bryn Mawr College. Allochthonous Blocks in the Martinsburg Shale of the Great Valley. Several new fossil localities and a few large blocks have been identified in Lebanon County.

C. E. PROUTY, Michigan State University. Chazy Rocks of Pennsylvania.

WALTER R. WAGNER, DANA R. KELLEY, and WILLIAM S. LYTLE, Pennsylvania Geological Survey. Stratigraphic Framework of Greater Pittsburgh Area, Part I. Initial report on distribution of rock types from surface to maximum depth of 2,000 feet. Consists of six cross sections covering Pennsylvanian - Permian Dunkard Group to Mississippian Pocono Formation in Allegheny and Washington Counties and parts of Beaver, Butler, and Westmoreland Counties. Part II will concentrate on Armstrong, Westmoreland, and Northern Butler County. Sponsored by the U.S. Geological Survey in cooperation with the Pennsylvania Geological Survey, the report will be one of the first publications of the Pittsburgh Regional Environmental Geology study.

STRUCTURE



INA B. ALTERMAN, Columbia University. Structure and Tectonic History of the Taconic Allochthon, Southeast Pennsylvania. Detailed mapping of the eastern end of Stose's "Hamburg Klippe" reveals a rock mass, probably emplaced by submarine gravity sliding, with a stratigraphy almost identical with the Taconic "slices" in southeast New York State, including a lower red-green slate and interbedded graywacke sequence and an upper black slate-carbonate sequence. Wildflysch conglomerates and detailed analysis of minor structures provide clues to mechanisms and time of deformation.

RODDY V. AMENTA, La Salle College. Structural and Metamorphic Geology of Wissahickon Formation near Philadelphia. Five sets of folds have been recognized in the schists near Philadelphia. The F_1 folds have an axial plane schistosity. The F_2 folds are overturned to the southeast and are probably related to fault emplacement of basement rocks (Baltimore gneiss) northwest of Philadelphia. Recumbent F_3 folds are penecontemporaneous with the major episode of metamorphism. F_4 folds with axial planes dipping to the southeast formed during the waning stages of metamorphism. F_5 (?) folds with steeply plunging axes and lineations are found locally adjacent to the granitized schist and to the northwest.

RODGER T. FAILL, Pennsylvania Geological Survey. Structure of the Triassic Basins in Pennsylvania.

DANA R. KELLY and WALTER R. WAGNER, Pennsylvania Geological Survey jointly with Mr. Samuel Cortis, Director of Bureau of Mine Subsidence, Department of Environmental Resources. Structure on the Pittsburgh and Upper Freeport coals for the Greater Pittsburgh area. Sponsored by the U. S. Geological Survey, in cooperation with the Pennsylvania Geological Survey, a report of the Greater Pittsburgh Urban Pilot Study.

SAMUEL I. ROOT, Pennsylvania Geological Survey. Investigation into basin Development and Tectogenesis of the Pennsylvania Part of the Central Appalachians.

ANNUAL FIELD CONFERENCE
of
PENNSYLVANIA GEOLOGISTS

October 8-9, 1971 Field trip through Northeastern Pennsylvania. Hosts: Pennsylvania Geological Survey. Pre-registration by Pennsylvania Geological Survey, Harrisburg, 17120.

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Directory of the Mineral Industry Available Again

Bulletin IC-54 (Second Edition), Directory of the Mineral Industry in Pennsylvania has just been republished by the Survey. This directory lists 465 non-fuel mineral operations producing rock and mineral raw material and products in the Commonwealth as of 1967. Two indexes are included to assist in locating producers by county and by company name.

Bulletin IC-54 is available from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125 for $1.80 plus 6% sales tax for Pennsylvania residents.

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NEW SURVEY PUBLICATIONS

IC-54	**Directory of the mineral industry in Pennsylvania** (2nd Edition) by K. V. Hoover (132 p., 1 map)	$1.80
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CUMBERLAND VALLEY AGATE

In the summer of 1967 while looking for Indian artifacts near Shippensburg, Cumberland County, some rounded chalcedony and agate concretions were discovered in a narrow zone across a field. They appeared to be very similar to the Mt. Holly Springs concretions.

Since the time of discovery this 200 foot wide zone was followed through the Cumberland Valley and the concretions are called Cumberland Valley agate. On the 1960 Geologic Map of Pennsylvania this zone is located in the Beekmantown Group. It occurs on the Plainfield, Newville, Walnut Bottom, Shippensburg and Scotland topographic maps from Mt. Rock in Cumberland County to Scotland in Franklin County. There is evidence that the zone continues both North and South from these points; however, this has not been researched thoroughly.

The concretions appear on the northwestern slope of the ridge that follows the entire length of the Beekmantown. Historically this ridge is well known. The Indian path known as Virginia Path, Great Trail or Potomac Road followed this ridge in order to avoid the

lower sometimes marshy portions of the valley and to take advantage of the springs that flowed from it, for example, Dunning's Spring, Big Spring, Middle Spring Creek, Falling Spring and Muddy Run Spring. Presently Route 11 and Interstate 81 follow a similar route and are adjacent or traverse the collecting area.

Farmers carry the largest concretions from their fields. One farmer reported one so large that he could not remove it from his field with a tractor. He dug a large hole with a backhoe, rolled it in, and covered it with ground. These unusual rocks have inspired some persons along the ridge to become "rockhounds" but none to our knowledge have cut or polished the agates.

Some sections of the zone have many concretions, other sections have few; however, the zone can usually be followed on the ridge by the elevation and type of soil. Agates from 6 inches in circumference (4 ounces) to 35 inches in circumference (40 pounds) have been found. Most agates are blue and white, black and white or brown and white. Occasionally other colors can be found.

Roger C. Miller
Shippensburg State College

BRADFORD, THE FIRST GIANT OIL FIELD

The 100th anniversary of the Bradford Oil Field is being officially celebrated during the week of August 16, 1971. It is most appropriate for us here to review the history and magnitude of this great natural resource of Pennsylvania where geology and geologists have played a vital role in its development.

The Bradford oil field is just 16 miles southwest of the Cuba oil spring whose description is possibly the earliest historical mention of petroleum found in the United States. The Bradford field, which covers over 100,000 acres, is located in the north central part of McKean County, Pennsylvania and the southeastern part of Cattaraugus County, New York.

Prior to 1871, a few wells were drilled for oil within the present limits of the Bradford field, but they were all dry, for drilling was stopped before reaching the Bradford oil sand. The first well sunk to the Bradford sand was drilled by a group of men under the name of Foster Oil Company, on the Gilbert farm, two miles notheast of the town of Bradford. The well, known as the Moses well, struck the producing sand at 1,110 feet in November, 1871. It had an initial production of 10 barrels of oil per day. From that date to December, 1874, 15 wells were drilled in the pool, none of them outstanding.

On December 6, 1874 Butts and Foster drilled a well known as Butts No. 1 on the Archy Buchanan farm, two and a half miles northeast of Bradford. This well, with an initial production of 70 barrels of oil per day, attracted the oil men and started the rapid development of the Bradford pool. By the end of 1879 there were 5,100 producing oil wells in the pool whose total average daily production was 45,000 barrels. Initial production of wells in the Bradford sand

probably did not average more than 50 barrels a day, although locally wells that produced as much as 1,000 barrels were found. The eastern lobe of the pool contained flowing wells. In 1881 the peak of primary production was reached, amounting to 22,945,069 barrels for the year. The Bradford pool covers 85,000 acres, 18 percent of which lies in the state of New York.

The period of flush production was followed by a gradual decline until 1906, when Bradford field production reached its lowest point, with an annual production of 2,022,000 barrels.

The first effects of waterflooding were noticed in 1907, but it is believed that flooding of the oil sand for increasing recovery was secretly practiced as far back as 1892. On May 17, 1921, a law legalizing waterflooding was approved by the governor of Pennsylvania.

Some average characteristics of the Bradford pool are: depth to sand 1,000 to 2,000 feet, thickness 50 feet, porosity 15 percent, permeability 10 millidarcys, oil saturation 30 to 60 percent, water saturation about 10 percent, about 100 cubic feet of gas produced per barrel of crude, gravity of crude 45.5 API, and a low original reservoir pressure of 350 lbs. per sq. in. (no good figure available). Due to the relatively low permeability of the sand and an original reservoir pressure that was probably subnormal, an unusually large percentage of the oil still remained in the sand after the economic limit had been reached by ordinary primary production methods.

The first waterflooding was dump flooding, where the casing was pulled in certain wells and the fresh and salt water allowed to go down the hole. The water penetrated into the oil sand, because of the hydrostatic head of the water in the hole, displacing the oil and forcing it to the producing wells. The early floods showed that this method was not wholly harmful and greatly increased production. Later a number of additional wells were drilled around the area of advancing water, for the old wells were often spaced too far apart for efficient flooding. Because of this additional drilling, the method became known as the "circle" flood.

In 1922, an operator realized that the old "circle" flood was a more or less haphazard operation, and started the "line" type of flood. In this method two rows of oil wells were staggered on both sides of an equally spaced line of water intake wells. Within two or three years, the oil wells reached their economic limit of production, at which time another row of oil wells was drilled ahead of the flood and the former oil wells were then converted to water intake wells.

In 1928, the "five-spot", a more intensive method of flooding, was introduced. An area was laid out in a pattern of squares with water intake wells at the corners of the square and the producing wells at their centers. At this same time, "Pressure flooding" was introduced. This development involved the application of additional hydraulic pressure to that of the hydrostatic head of the column of water in the intake well. This method forced more water into the sand, thus displacing more oil and moving it into the well bore of the producing well. In general, 10 or 25 barrels of flood water are required to produce a barrel of oil.

The pressure applied in the intake well may be as high as 1,500 to 2,000 psi at the sand face.

The cost of drilling and equiping a producing oil well in 1880 was $3,250 in the Bradford field. Today the cost is about $12,000.

The Bradford region gained recognition as the greatest secondary recovery laboratory in the world. Many improvements in oil recovery techniques came out of research in this region: Waterflooding progressed from dump flooding to the more efficient five-spot flood. Input wells were tubed. Coring was initiated. Methods for determining porosity and permeabilities were invented. Pressure flooding was introduced. Improvements were made in drilling and cleaning out. Selective shooting was introduced. Selective plugging was used successfully in some areas. Interpretation of electric and other logs improved. Wells were better spaced for maximum oil recovery. Pumping schedules were improved. Knowledge of water treatment increased. Pilot projects in fire flooding, steam flooding, CO_2 pressuring, exhaust gas pressuring, and miscible displacement have been undertaken. Currently a "Maraflood" is underway on a 50 acre tract.

In spite of a century-long production history, 50 to 60 percent of the oil originally in place in the Bradford field is still contained in the reservoirs. Waterflooding is still being used to produce the oil, although production by secondary recovery is down to 2,760,000 barrels per year from its peak during 1937 of 16,454,744 barrels. A total of 646,749,571 barrels has been produced from this giant field. Of this total, 273,136,571 barrels can be attributed to primary recovery while 373,613,000 barrels have been produced by secondary recovery methods. The total income realized from this one field has amounted to about $1,635,115,000. Pennsylvania's share of this income is about $1.4 billion. Of the total oil produced to the end of 1970 in Pennsylvania, which amounts to 1,269,489,000 barrels, over 43 percent was produced from the Pennsylvania part of the Bradford field.

A giant field is generally classified as one that has produced one-half billion barrels of oil. Using this classification, the Bradford field is not only the first giant field discovered in the world but it is the largest giant field east of the Mississippi river. The only other field in the eastern United States that falls within this classification is the Old Illinois field of the state of Illinois; its cumulative production to date is 14,000,000 barrels less than that of the Bradford field.

In this centennial year of the Bradford field, we might ask what is in store for this field in the years to come. If Maraflood or some other tertiary recovery method provies economically feasible, the field could produce as much as it has in the past, at least produce many millions of barrels more of crude oil before abandonment. If waterflooding continues to be the main recovery method, production will continue to decline and the life of this giant field would be terminated in the not too distant future. It behooves the operators in the field to find a tertiary recovery method that will produce the millions of barrels of oil still in the ground for the economic security of the area and the recovery of additional Pennsylvania Grade crude that might otherwise be lost forever.

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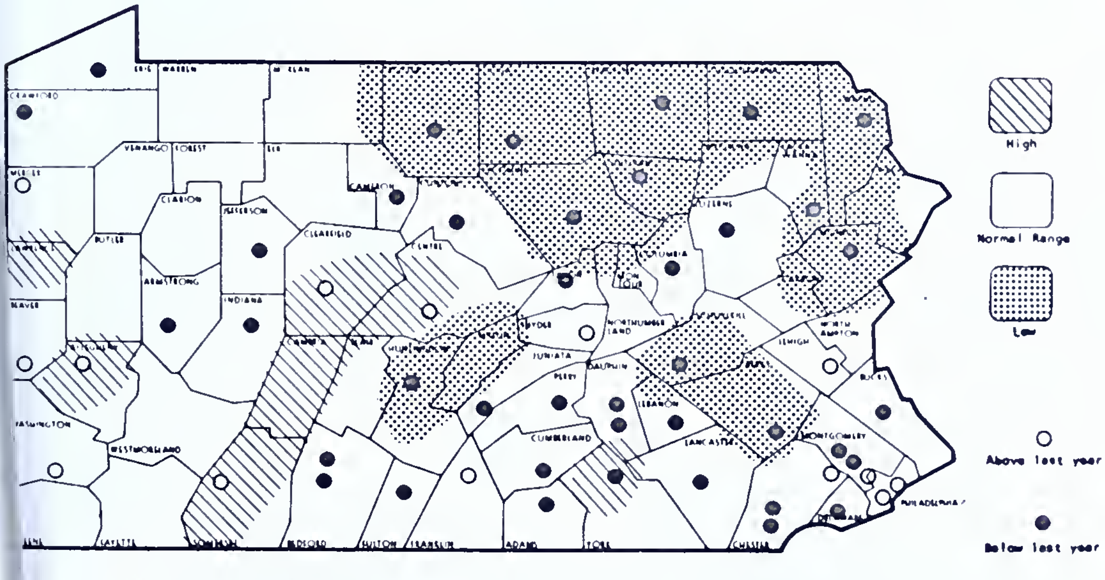

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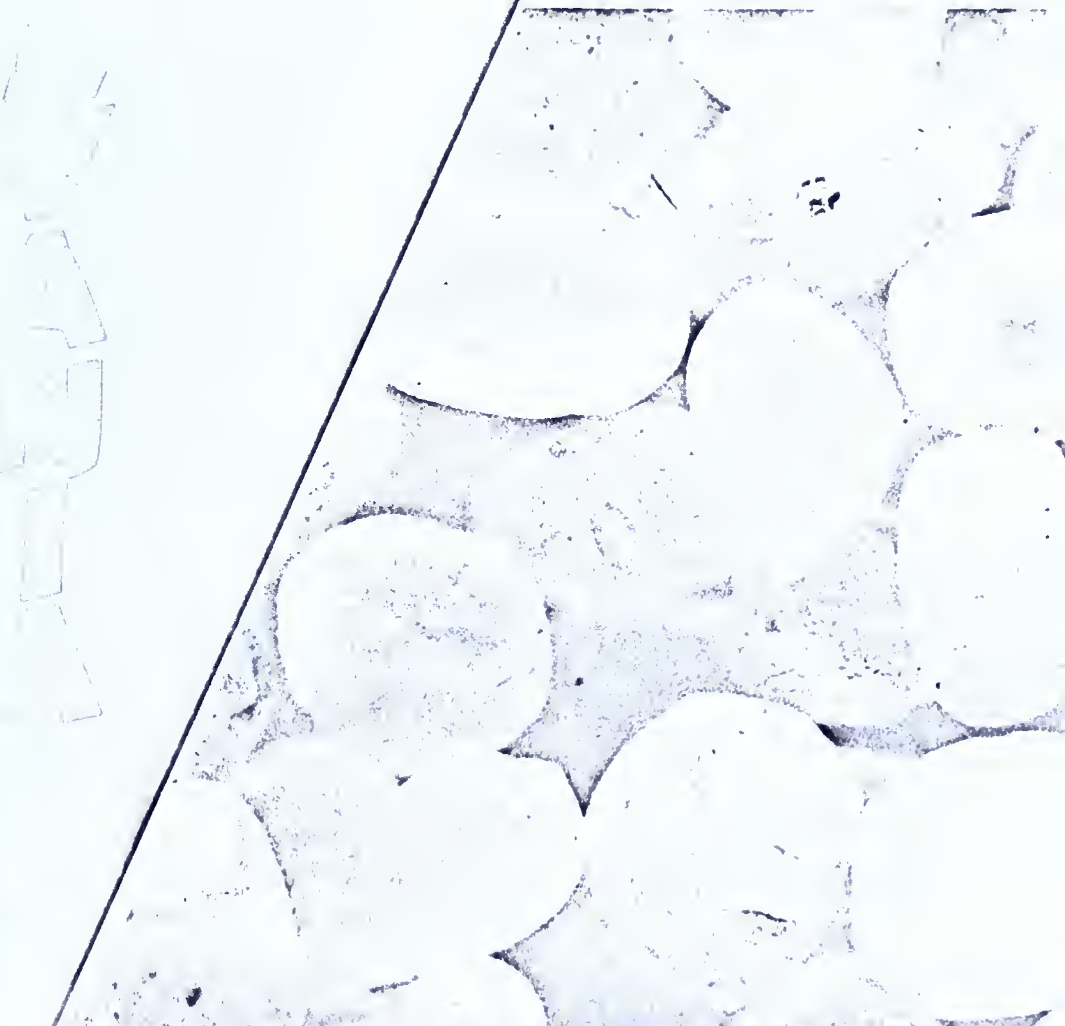

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ON THE COVER — Highly magnified sand grains show a high degree of rounding and frosted surfaces indicative of having been transported by wind. Grain shape is a factor which controls the possible economic use for the sand (Photo courtesy of David E. Snell, College of Earth and Mineral Sciences, The Pennsylvania State University.)

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OCTOBER 1971

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

WE CAN HAVE OUR CAKE AND EAT IT TOO

This bulletin carries two articles of significant interrelationship: the story of Pennsylvania's high national ranking as a mineral producer and the report on the Commonwealth's membership in the Interstate Mining Compact Commission aimed at guiding the state's development of mining regulations. To these news developments concerning the mining industry might be added the progress of the current All Surface Mining Bill in the Pennsylvania Legislature, and a similar federal bill in Washington which is undergoing committee hearings.

The reports of Pennsylvania's increased mineral production and that of state and federal moves to regulate mineral production suggest opposing economic-social forces. Yet each of these is so vital to our society that it is an urgent necessity that we arrive at a reasonable modus vivendi.

On one hand we have Pennsylvania's annual production of a billion dollars worth of raw minerals each year which not only provides over 10 million man days of work, but also furnishes the vital fuels to heat our homes and drive our machinery, as well as the raw materials to build our houses, factories, roads, and appliances we demand as part of our way of life. More mineral fuels, whether they be coal, oil, gas, or atomic, are needed to keep up with the energy demands by our vehicles, homes, and industries. Industrial minerals are needed to supply our factories so we may continue to have tools, glassware, vehicles, stoves, refrigerators, utensils, drugs, etc. Construction minerals are necessary to supply the concrete, brick, stone, roofing, etc., needed to build our homes, roads, schools and factories.

On the other hand those vital mineral needs cited above must not be accomplished heedless of the environmental impact. We can no longer accept physical and chemical pollution, nor surface degradation as by-products of mining. People in all walks of life, including most of the mineral industry as well as government officials, are recognizing and acknowledging that to maintain the vital mineral industry and our standard of living, we must take the necessary steps to make it compatible with a quality of life that is acceptable.

And so, the stories of Pennsylvania's high mineral production, and of the Mining Compact, and of state and federal mining legislation are not incompatible. We must make them compatible so that responsible mining can continue. We need to have our cake and eat it too.

Arthur A. Socolow

PENNSYLVANIA MINERAL INDUSTRY CONTINUES GROWTH

The mineral industry of Pennsylvania showed an 8 percent increase in total production value for 1969 over that for 1968. The 1969 mineral production value in Pennsylvania was $976.4 million and accounted for nearly 10 million man days of work during the year. This figure places Pennsylvania as the fifth largest mineral producer in the nation, and the largest producing state east of the Mississippi River. Pennsylvania's mineral production for 1969 was 2.7 times the dollar value of her other major natural resources, forestry and agriculture.

Coal, cement, and stone were the major commodities produced. Mineral fuels (coal, oil, and natural gas), accounted for 63 percent of the overall production value; nonmetals accounted for 34 percent and metals 3 percent. The total annual coal tonnage was greater than the previous year. However, anthracite tonnage decreased by 9 percent but its market value increased from $97.3 million (1968) to $100.8 million (1969). Both the production and value of bituminous coal increased in 1969. The value of all coal mined was $562.4 million, accounting for 58 percent (versus 55 percent in 1968) of the state's mineral income.

Washington County was the leading mineral producer in the state, followed by Greene County. Coal accounted for $95 million worth of Washington County's value plus an undisclosed value for stone and clays. Greene County's $90 million of production all was from coal. Northampton County was third with $61 million production of cement, stone, sand-gravel, and slate. Schuylkill county was the leading producer of anthracite coal and Washington County for bituminous coal.

Nine hundred eighty-six new oil and gas wells were drilled during the year. Indiana County continued to be the most active natural gas area, with 121 successful wells completed. Northampton, Centre, Montgomery, and Bucks counties continued to be the leading producing counties of cement, lime, stone, and sand-gravel respectively. Clay was produced in 28 counties, led by Clearfield and Lawrence counties.

Review of the mineral industries data collected by the U. S. Bureau of Mines for the nation as a whole reveal many interesting facts about Pennsylvania. For example, the anthracite summary pertains exclusively to Pennsylvania, for Pennsylvania is the only state commercially mining anthracite. The only domestic source of cobalt (a by-product from pyrite concentrate) is Pennsylvania. Pennsylvania's only zinc mining district is areally limited to a few square miles, but is has been an intermittent zinc mining district since 1845; presently only one mine is working, the Friedensville Mine, Lehigh County, yet this mine produced nearly 1 percent of all zinc mined in the United States during 1969. Cobalt, copper, gold, and silver, present as accessory minerals in the iron ores being mined in Berks and Lebanon counties, are extracted and contribute to the mineral wealth of the state.

In 1969 Pennsylvania was the nation's leading producer of stone, second among all states in both value and tonnage for lime and cement, second in value of clay mined, and third in total tons of bituminous coal produced.

Detailed data on Pennsylvania's mineral industry is contained in the Pennsylvania Geological Survey's new Information Circular 71, **The Mineral Industry of Pennsylvania in 1969.** This booklet may be obtained at no cost from the Pennsylvania Geological Survey at Harrisburg.

PENNSYLVANIA IS MINING COMPACT MEMBER

Pennsylvania is a charter member of the newly organized Interstate Mining Compact Commission. The Commission formally came into existence at a meeting at Raleigh, North Carolina, on April 27, 1971. Representatives of the four charter member states were in attendance: Kentucky, Pennsylvania, North Carolina, and Oklahoma. Also present were representatives of eleven non-member states which are considering membership and which contributed to the organizational discussion. At the organizational meeting, Dr. Arthur Socolow, State Geologist and Director of the Pennsylvania Topographic and Geologic Survey, represented Governor Milton Shapp. At the April meeting Governor Louie Nunn of Kentucky was elected Chairman of the Commission for the year, and Governor Robert Scott of North Carolina was elected Vice-Chairman.

At the organizational meeting it was emphasized that the purpose of the Interstate Mining Compact Commission is coordination and exchange of surface mining information and developments among the states. It was stressed that the Commission, patterned after the long-established Interstate Oil Compact Commission, is not intended nor organized as an interstate regulatory body. Rather, each state will have an opportunity to learn and benefit from the experiences of the others, and where practical, the states will strive individually to develop uniform standards and practices. Current emphasis of the Commission, in recognition of needs, is placed on the subject of reclamation of mined lands. However, this will only be part of the overall program of the Commission.

It was agreed at the organizational meeting that for the time being, the secretarial and staff work of the Commission would be performed by the office of the Council of State Governments, located in Atlanta, Georgia, under the direction of Herbert L. Wiltsee, Manager.

THE EAGLE FLIES AGAIN

Perhaps you have noticed: a new marble eagle is back on the Federal Building in Harrisburg at the Walnut Street entrance. The old eagle never quite took flight. The Pennsylvania Geological Survey had examined the original marble and found that its failure under the sculptor's tools was a result of its coarse grain size and very small fractures. We suggested that the sculptor go to the source (Vermont) to select his marble. He did just that; in fact he sculpted it

in the quarry and then shipped it to Harrisburg. Hopefully our new marble eagle will have a flawless flight through the years.

CHANNEL SANDSTONES IN COAL

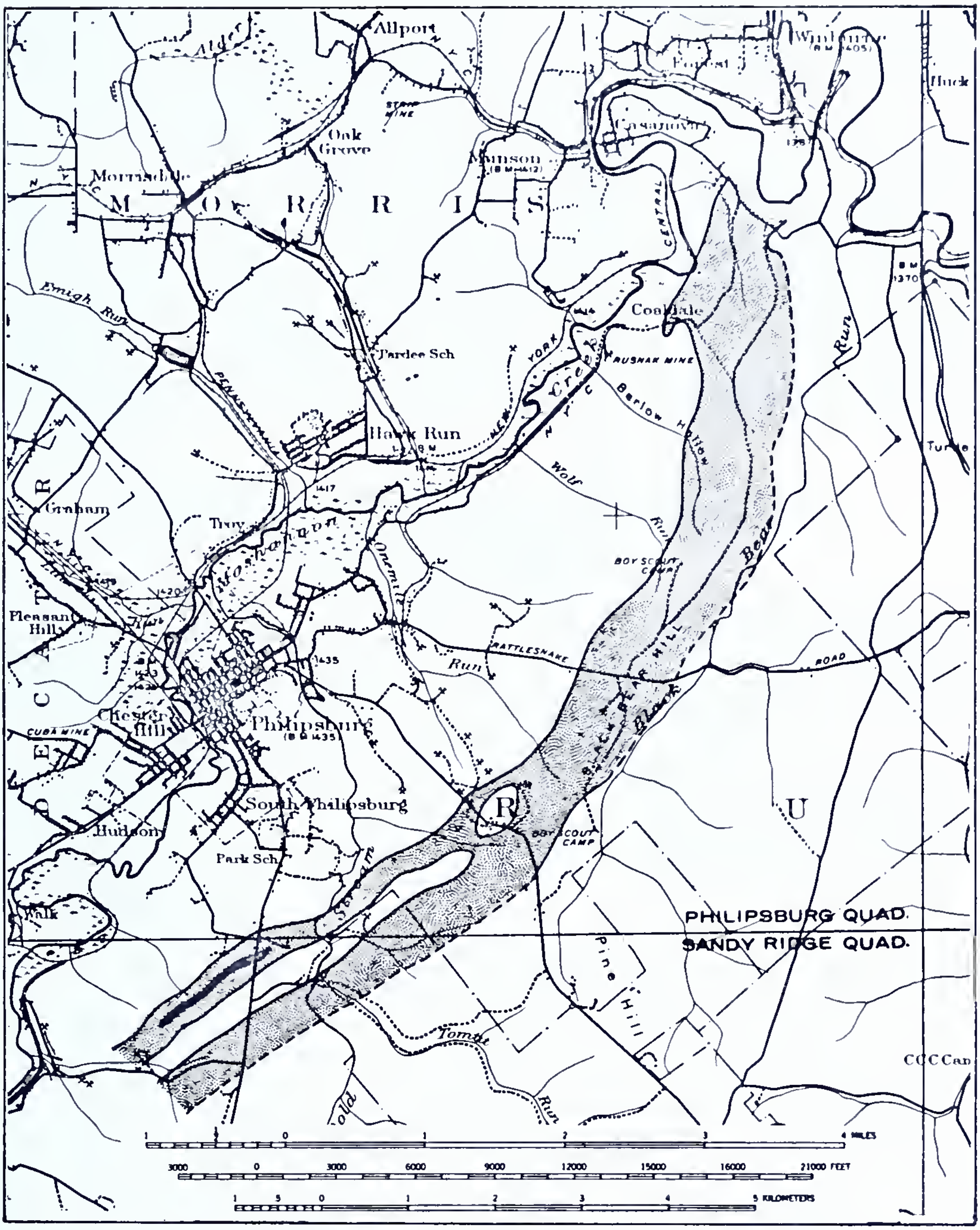
Fluvial sandstones, variously called channel or shoestring sandstones, are quite common in the bituminous coal measures of Pennsylvania. The Kittanning sandstone in a portion of Centre County, provides an excellent example of the basic geometry and behavior of one of these fluvial sandstone units. Geologic mapping of the Philipsburg 7½-minute quadrangle showed that there were enough surface exposures of the Kittanning sandstone to delimit its occurrence and trend in that area.

As the Kittanning sandstone overlies the Clarion coal, the technique used to outline the boundaries of the sandstone required only identification of the rock type immediately overlying the Clarion coal (roof rock). This was done wherever it was exposed in road cuts or strip mines. The stipled pattern on the accompanying map represents that area where the Clarion coal seam is directly overlain by the Kittanning sandstone. Solid colored areas are where the sandstone channel has cut out the coal. Clear white areas east and west of the stipled pattern and at places within it, indicate where the sandstone gradually rises up to 30 feet above the coal. In these white zones, shale occupies the interval between the sandstone and the coal. This shale roof rock thickens rapidly at first then gradually with greater distance from the stipled area at the expense of the Kittanning sandstone which rises and thins as the shale thickens. The extension of this sandstone's occurrence into the Sandy Ridge 7½-minute quadrangle is based on drill hole information supplied by Rushton Coal Mining Company, Inc. which operates the Rushton mine on the Clarion coal in this area.

This narrow, sinuous, northeast-southwest trending sandstone is the remnant of an ancient southerly flowing river through this region. During the process of erosion, this stream cut a 30 to 50 foot deep, relatively flat-bottomed valley into the shales that normally overlie the Clarion seam. The width of the valley ranged from 0.5 miles to 0.8 miles across although in the Sandy Ridge 7½-minute quadrangle, it bifurcated into two narrower channelways that left a shale island between them. The sandstone is known to continue its general trend to the southwest into the Houtzdale 7½-minute quadrangle while its northeastern continuation is less clear but nonetheless predictable.

As this river matured, it deposited sands and gravels in its original valley in place of the eroded sediments. The Kittanning sandstone is the consolidated remnants of those sand and gravel deposits. Its three-dimensional shape reflects the original position and cross-section of the ancient river valley. The outside edges of the stipled area approximate the position of the valley walls.

In the Rushton mine, the main channel of the stream occasionally cuts through the Clarion coal and into the older underlying rocks (solid colored area on map). The width of the cut-out ranged between 100 and 300 feet. Similar



cut-outs of the coal can be expected to occur at other points along the course of the stream. Since the sandstone now fills the ancient river valley from bank to bank, it obviously occupies the original position of the Clarion seam in these cut-outs. The coal is, of course, present at or near the same level on both sides of such a "rock fault".

"Rock Faults" are not uncommon in the mining history of the area or for that matter in Pennsylvania's coal measures in general. Since mechanical mining equipment is not designed to cut through these hard sandstone bodies, the cut-outs pose an especially formidable obstacle to modern underground coal mining. This mechanical equipment is often seriously damaged by impact with

unsuspected sandstones of this type. Additionally, costly rock headings (tunnels) often must be driven through the sandstone to reach coal acreage on the other side of a cut-out. Even when a channel sandstone merely overlies a coal seam, it is quite likely to produce adverse roof and water conditions.

Although the fluvial-type sandstone is common, it is not the only type of sandstone unit that occurs in the coal measures. Many sandstones do not occupy old river channels and consequently are not found to replace or cut-out the coal seams as in the above example. A fluvial-type sandstone must be identified as such, whenever possible, so that its potential effects on mining can be anticipated and so that predictions of its course through adjacent properties can be made. Only when the position of such a sandstone body is known in advance can a mine be laid out to minimize the sandstone's effect on the mine's operation and development.

Gary B. Glass

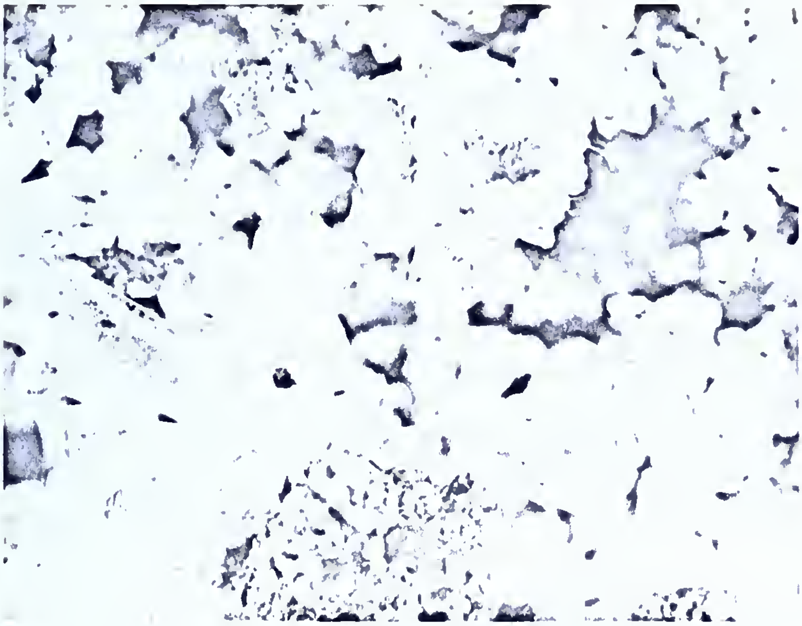
RARE MINERALS FOUND IN PENNSYLVANIA

A recent article in **Pennsylvania Geology** (Lapham, 1971) described an interesting new occurrence of native sulfur in Schuylkill County at the Kehley's Run Mine, a burning anthracite strip mine near Shenandoah Heights. Additional work has now revealed some exciting finds of rare micro-crystals.

The mineral collector who discovered this sulfur, Mr. Wayne Downey of Harrisburg, has since that time made several more trips to the mine area and has returned with additional specimens for study. These specimens were analized optically and by means of X-ray diffraction by the Pennsylvania Geological Survey. Some of them have never before been reported from Pennsylvania or from eastern North America.

The most common mineral found at Kehley's Run Mine, other than native sulfur, is salammoniac, composed of ammonia and chlorine. This mineral forms as a clear or white crystalline crust on exposed rock surfaces, deposited by fumes from the burning coal. According to Samuel Gordon's **Mineralogy of Pennsylvania** (1922), this mineral has been found previously in Pennsylvania only at the Burning Mine at Summit Hill in Carbon County. Outside the Commonwealth, it is commonly found associated with volcanic fumaroles, and has been found at burning coal mines in Germany, France, and England (Palache et al, 1951).

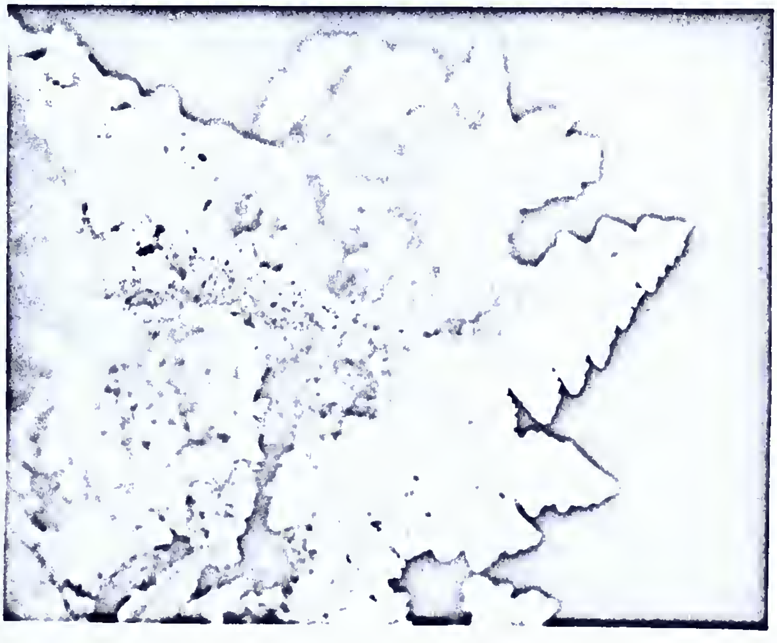
Two less common minerals at this site are cryptohalite and bararite, both of which are forms of ammonium silicon fluoride. The cryptohalite is considerably more abundant than the bararite, and forms crystals similar to salammoniac. Indeed it is almost impossible to tell them apart visually. The bararite is present only as tiny crystals which are usually at least partially enclosed by the cryptohalite crystals. Neither of these minerals has been reported previously from a Pennsylvania locality. According to Palache, et al (1951) the only other known occurrences of these two minerals are at Mt. Vesuvius in Italy, and at burning coal mines in India and Bohemia.



SALAMMONIAC

Still another rare mineral at Kehley's Run Mine is mascagnite, which is an ammonium sulfate. This mineral occurs as small pale-yellowish needles, in small clear needles, and as large, feathery aggregates of crystals. This mineral is another which has not been previously reported from Pennsylvania. Palache, et al (1951) reported that it is found associated with volcanic fumeroles in Italy and the Congo, and at burning coal mines in France, England, Scotland, and Czechoslovakia. In the United States, the only other occurrence is at the Geysers in Sonoma County, California where mascagnite occurs as a thick crust rather than

MASCAGNITE



as individual crystals. This occurrence in Pennsylvania has proven to be of such interest that the Smithsonian Institution in Washington, D.C., has obtained a sample collected by Mr. Downey and identified by the Survey for its collection.

Other material found at Kehley's Run Mine includes small cubes of galena, lead sulfide, which is coated with an irridescent blue film. Other minerals found here are kaolinite, quartz, and hematite. Other rare minerals occur in such small quantities intermixed with those described that their identification has not proved possible.

The Kehley's Run Mine is now closed to mineral collectors as new efforts are under way to extinguish the fires. However, during the short interval from the discovery of this location until it was closed, a rare opportunity was provided for collectors in eastern Pennsylvania to obtain specimens which would be an outstanding addition to any collection and to advance our scientific knowledge of these rare species.

John Barnes
Davis Lapham

REFERENCES

Gordon, S. G. (1922), **The Mineralogy of Pennsylvania**, Academy of Natural Sciences of Philadelphia Special Publication No. 1, 255 p.

Lapham, D. M. (1971), **Native Sulfur in Pennsylvania.**, Pennsylvania Geology, v. 2, n. 1, p. 14-15.

Palache, C., Berman, H., and Frondel, C. (1951), **Dana's System of Mineralogy, Volume II.** John Wiley and Sons, Inc., New York, 1124 P.

MINERALS AND MINERAL LOCALITY PRESERVATION

A new international society recently has been establihsed for both professional and amateur mineralogists, with an emphasis on bridging the gap between the scientist and the collector. The society is called the Friends of Mineralogy. Articles and news items are published in the excellent new magazine, the Mineralogical Record (P. O. Box 783, Bowie, Md. 20715). One of the important functions of the new society will be to gather data on and preserve important mineral collecting localities all over the world. The exact locations of some localities have become lost; for others, the mineralogy is not adequately described. Entry to some is not permitted or soon will become closed for a variety of reasons. The Minerals Preservation Committee, presently chaired by Dr. Davis Lapham of the Pennsylvania Geological Survey, is now beginning work on these problems. The ideas and cooperation of all who are interested in mineral and mineral locality preservation are welcomed. Information about the FM Society may be obtained by writing to Mr. Richard Bideaux, 1242 W. Pelaar Street, Tucson, Arizona, 85705.

STRATIGRAPHIC FRAMEWORK OF PITTSBURGH AREA ON OPEN FILE

In January, 1971, the Pennsylvania Geological Survey in cooperation with the U.S. Geological Survey began a study of the environmental geology of the Pittsburgh area; the Pittsburgh area includes Allegheny County and the five surrounding counties of Beaver, Butler, Armstrong, Westmoreland, and Washington. The initial project of the study was the preparation of a stratigraphic framework of the surface and nearsurface rocks. This will serve two purposes: first, the stratigraphic data on the nature and distribution of the various rock types in the area will be of use in succeeding phases of the environmental study, and second, stratigraphic data in the form of cross sections illustrating the vertical and horizontal relationships of the rock strata will be a valuable guide to anyone engaged in excavation, construction, or drilling in the area.

The part of the stratigraphic framework which has been completed is entitled **Stratigraphic Framework of Greater Pittsburgh** Area - **Part 1.** Allegheny, **Washington, Beaver and southern Butler Counties**, by W. R. Wagner, D. R. Kelly, and W. S. Lytle. The report consists of four cross sections (vertical scale 1" = 50') which show the distribution of rock types from the surface to a maximum depth of 2,000 feet. The stratigraphic interval ranges from the Mississippian Burgoon Sandstone Member of the Pocono Formation to the Pennsylvanian and Permian Dunkard Group. The rock types shown are coal, shale, claystone, siltstone, sandstone, and limestone. The data used in assembling the cross sections have been obtained from three main sources: 1) core hole descriptions from coal companies and engineering firms, 2) sample descriptions and gamma-ray logs from wells drilled for oil and gas, and 3) measured outcrop descriptions.

This report, consisting of four cross sections (6 sheets each 36" x 60"), 13 pages of text, five figures, and one table is on open file at the following offices:

Pennsylvania Geological Survey
401 Pittsburgh State Office Building
300 Liberty Avenue
Pittsburgh, Pennsylvania 15222

U. S. Geological Survey
102 East Mall (Second Floor)
P. O. Box 420
Carnegie, Pennsylvania 15106

The report is available for examination at the offices listed above and copies of the report will be made available at the expense of the individual.

Part 2 of the stratigraphic framework covering Armstrong, Westmoreland, and northern Butler County is currently being compiled and will be available late in 1972.

KINK BAND FOLDING IN CENTRAL PENNSYLVANIA - I. KINK BANDS.

One of the most important responsibilities of survey geologists is to describe the different rocks in project areas and show their detailed distribution on a map. In the course of gathering raw data in the field, a geologist often notices features which may answer more fundamental geologic problems. Solution of these basic problems provides explanations for otherwise perplexing geologic relations, thereby enabling the geologist to make more accurate descriptions of the geology as well as expediting his and other mapping projects. An example of this is the recognition of kink bands in the Valley and Ridge province in central Pennsylvania and their incorporation into a structural geologic model which explains the distinctive fold geometries that are reflected by the long, parallel ridges and valleys in central Pennsylvania. This model revises the existing concepts of the rock deformation that occurred more than 200 million years ago in this part of Pennsylvania. The "Kink band" model will be explained in a series of articles, or which this is the first, which will be continued in future issues of Pennsylvania Geology.

A kink band is a relatively simple geologic structure. It consists of a (usually) parallel-sided zone of rock that has been rotated relative to the rocks outside of the zone (Fig. A, and B). The bending of beds occurs only at the boundaries of the kink band, which are called the kink planes. The beds between the kink planes are not bent, but only rotated, and thus they have remained planar and parallel. The axis around which the beds have been rotated is the kink

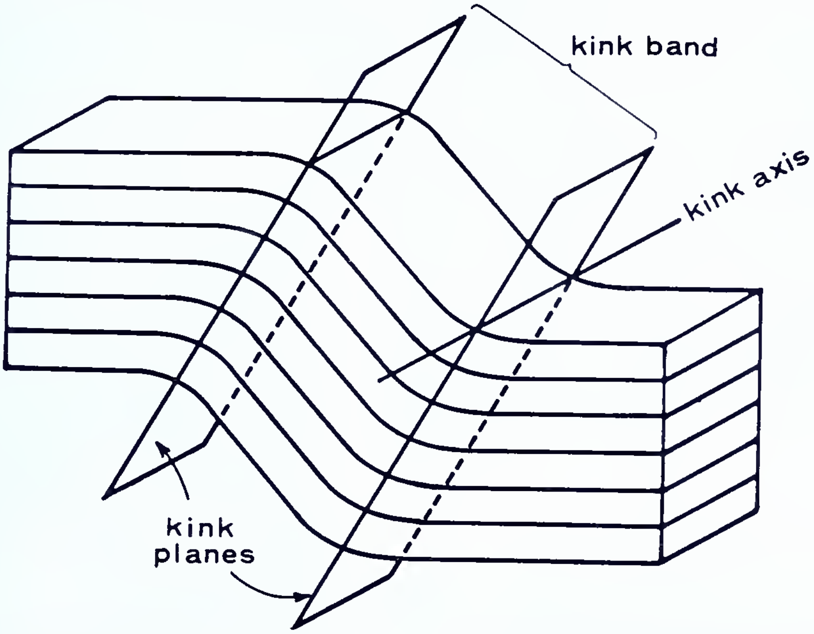


Figure A. Idealized kink band illustrating kink planes and kink axis. Kink band consists of rotated beds between the kink planes.

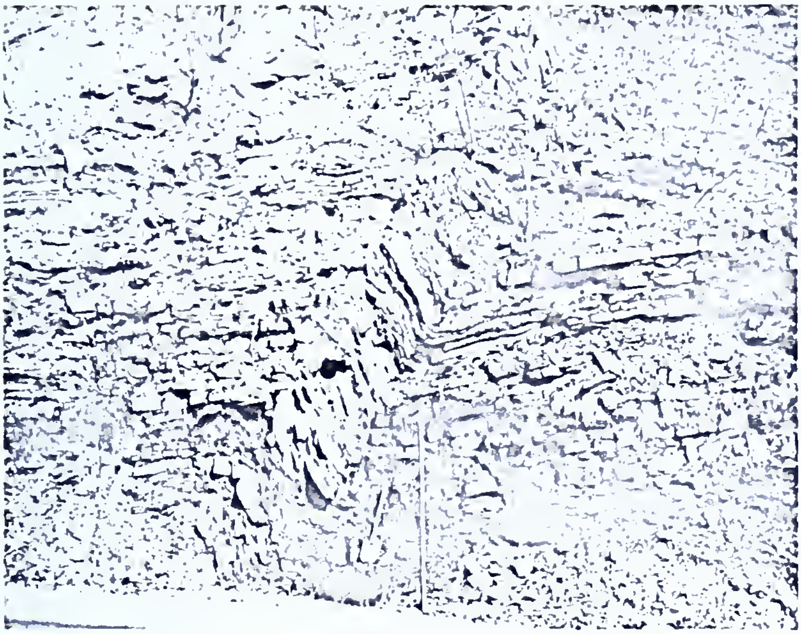


Figure B. Kink band in Silurian Rose hill Formation, 2 miles southwest of Lewistown, Pa., along Pa. Route 103.

axis, and this axis is analogous to the fold axis of a fold. Although the beds outside the kink planes are not part of the kink band, the kink band exists only in relation to these enveloping rocks, in much the same way that a fault exists only in relation to the rocks on each side of the fault.

Kink bands generally lie at a large angle to the enclosing bedding and represent a shortening of the rocks parallel to the major direction bedding. Experimental work has shown that kink bands develop only when the maximum principal stress is parallel, or nearly parallel, to the bedding.

Previously described kink bands from other areas are small (1 to 2 inches). Kink bands of this size occur in the Valley and Ridge province (Fig. C), but most of them are much larger (Fig. B). The factor that seems to control the size of a kink band is the thickness of the bedding layers. Small kink bands are able to develop in very thin bedded rocks, whereas in thicker bedded rocks, the kink bands are larger. Few very large kink bands are seen because outcrops are generally not large enough to show the entire breadth of the kink band and the enveloping rocks. The occasional exposures of very large kink bands are often impressive (Fig. D).

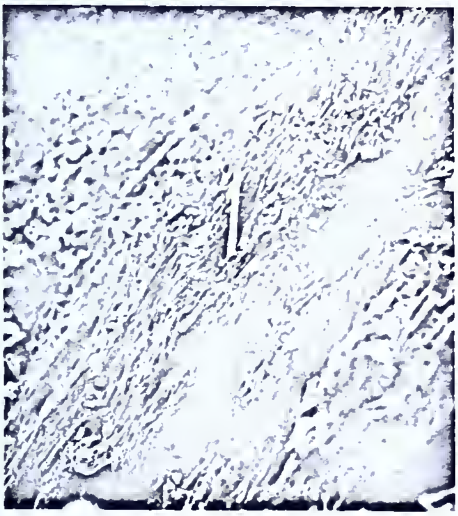


Figure C. Small kink band in Silurian Wills Creek Formation, in Little Pfoutz Valley, 2 miles north of Millerstown, Pa.

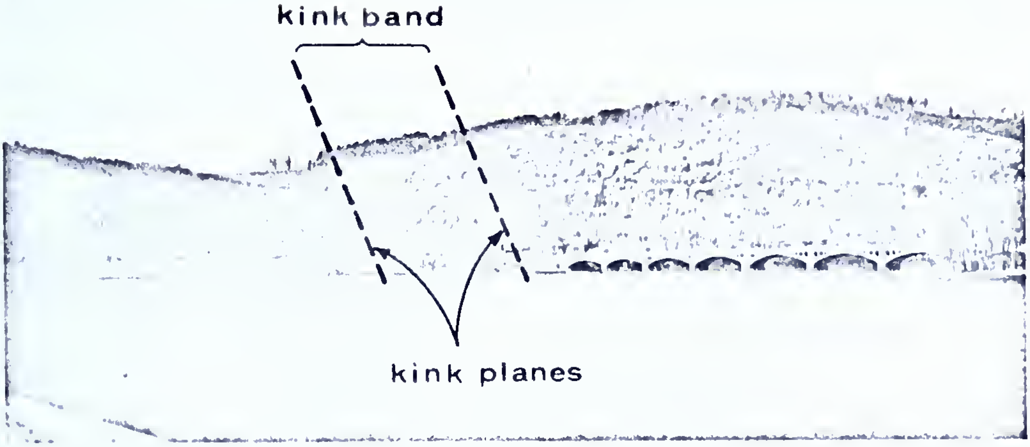


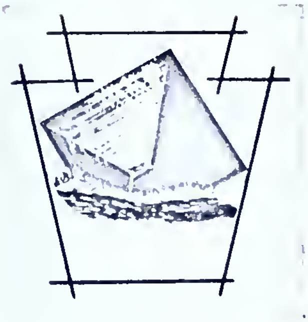
Figure D. Large kink band in Devonian Catskill Formation on west bank of Susquehanna River, opposite Northumberland, Pa.

Thus kink bands, previously unreported for this area, occur in the Valley and Ridge province ranging in size from small to very large. But the mere presence of kink bands in this folded terrain is not their primary significance. What is significant is that common geometrical elements exist between the kink bands and the folds. Valley and Ridge folds have usually been thought of as concentric folds, but detailed mapping has shown that they possess planar bedding in the limbs and narrow fold hinges, a geometry not consistent with concentric folds. In contrast, the planar geometry of the folds is similar to the planar quality of the kink bands. This, in addition to the large size of many kink bands, suggests that the kink bands and folds are intimately related. Just how folds are generated from kink bands will be discussed in a subsequent article.

Rodger Faill

NEW SURVEY PUBLICATIONS

IC71	**The Mineral Industry in Pennsylvania in 1969** by C. Gordon Leaf (20 p. 2 figs.)	Free



EARTH SCIENCE TEACHERS' CORNER

u.s.g.s. leaflet series

Several new U. S. G. S. leaflets have been added to this popular geology series. The emphasis still appears to be on water with the release of two additional pamphlets on the subject:

"the Amazon - measuring a mighty river", 15 p.
"Glaciers - a water resource", 23 p.

These leaflets are available from the U. S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia, 22202, free of charge.

pennsylvania and apollo 15 moon rocks

Two of the most exciting aspects of the most recent lunar exploration involved the search for rocks older than 3.5 billion years and the search for a coarse-grained igneous rock representing an early magma (molten rock material). The oldest Moon samples which had previously been dated are believed to be about one billion years younger than the earliest formation of rock on the Moon. The hope was that a sample of anorthosite rock from the Highlands would be one of the oldest Moon rocks. Anorthosite, a rock composed almost wholly of plagioclase feldspar, was predicted for the Highlands from a study of Apollo 11 Moon samples. Thus, when Scott and Irwin found what they believed to be anorthosite, excitement on the Moon and the Earth ran high.

Anorthosite is not a common rock. Most occurrences on Earth are very old, an age of about 1.0 billion years or older. Anorthosite occurs in Pennsylvania a few miles north of Coatesville and nowhere else in the state. (Its occurrence is shown on our Pennsylvania State Geology Map). Its exact age in Pennsylvania has not been measured to date. However, it is associated with rocks at least 600 million years old. Indeed, the Pennsylvania anorthosite may be as old as the oldest dated rocks in the state, which are from the Baltimore Gneiss Formation in Chester County, found to be 1.1 billion years old. The old age of Earth anorthosites and their origin by crystallization from a molten magma at depth are prime reasons for believing they will clue us in to the early history of the Moon. Consequently, Pennsylvania rocks have played a small but important part in theories leading to the development of our Moon exploration program.

MAN AND HIS GEOLOGICAL ENVIRONMENT

Throughout history and throughout the workd there are many examples of geologic hazards which have affected the activities of man. In Quebec recently a housing development subsided and people were killed as the result of building the housing development on sensitive clay. In Italy, Vesuvius exploded nearly 2000 years ago and preserved a city for the ages. In Beaver County, Pennsylvania a housing development was nearly destroyed because a mine subsided. In addition there are many other potential geologic hazards in the world including floods, landslides and water pollution. Most of these disasters could have been avoided with adequate geologic investigation.

The man who can adequately make this investigation is the engineering geologist. A geologist is a man who studies the earth. He is a scientific detective. In order to become a geologist he must have a background in all of the sciences including mathematics, biology, chemistry, physics and geology. He must also be well acquainted with our natural resources including coal, oil, metal ores and natural building materials. With adequate study the geologist is able to help society alleviate the problems of water pollution, mine subsidence and even volcanic eruptions. In many areas there is a need to use the geologist in the evaluation of sites for proposed construction projects.

The geologist investigating a building site must first evaluate all of the geologic information available in the area. For that reason a broad base of geologic information is especially valuable. He can get this information from private sources, the U.S. Geological Survey and state surveys.

After evaluating the available geologic data, the geologist must then evaluate the engineering problems that may be encountered in the construction of the project. How far down will rock be found? Where will groundwater be encountered? Will there be enough good quality groundwater to supply water or must water be supplied from outside the project? What will be the effect of this project on the environment? Will it cause landslides? Will it cause pollution? These are some of the questions that must be answered by the geologist.

After he knows the general geology of the area and the questions that must be answered, the geologist must then plan a way of finding the answers to the questions. He may drill holes to examine the rocks and determine their condition. Once the holes are drilled he may lower a camera into the hole to determine whether or not there are mine voids that will cause problems. He may use electrical methods to determine if limestone sinkholes are present, and if they are present how far they go. He may test the water in the area with chemical methods to determine if it is good enough for use on the project. After he has obtained his information, he will prepare his report for use in the construction of the project. Using the information he has obtained, he can predict and alleviate problems such as mine subsidence, landslides, water pollution, and flooding before construction and before these problems become serious and cause hundreds of thousands or even millions of dollars worth of damage.

What can the average man do? He can support broad geologic research to provide a basis for more detailed studies. He can insist on geologic investigations when projects such as housing developments are built. He can proceed with construction when geologic conditions are favorable or insist that geologic hazards are corrected before construction begins. Ultimately he can, when backed with geologic knowledge, stop the construction of projects which may be ecologically or economically unsound.

John A. Blair
Geologist
Michael Baker, Jr., Inc.

OVER 2,000,000 TONS OF COAL FROM 8 IN PENNSYLVANIA

Eight of Pennsylvania's bituminous coal mines each produced more than 2,000,000 tons of coal in 1970. United States Steel Corporation's Robena mine in Greene County not only outproduced all other Pennsylvania mines but ranked as the 10th largest in the United States with an annual production of 3,873,000 tons of coal. United States Steel Corporation's Maple Creek mine was the second largest producer with 2,629,000 tons. Arranged in descending order, the remaining Pennsylvania mines producing over 2,000,000 tons of coal were: Rochester and Pittsburgh Coal Company's Jan Nos. 1 & 2 mines with 2,187,839 tons, Duquesne Light Company's Warwick mine with 2,186,453 tons, Consolidation Coal Company's Montour No. 4 mine with 2,176,000 tons, Mathies Coal Company's Mathies mine with 2,060,000 tons, Gateway Coal Company's Gateway mine with 2,049,000 tons and C & K Coal Company's Fox mine with 2,036,000 tons.

C & K Coal Company's Fox mine, which was the only open pit operation to exceed the 2,000,000 ton mark, ranked 40th in production nationally.

Gary B. Glass

COW DUNG PLUS GLASS EQUALS BRICK!

When California ranchers turned to the University of California to help them find a way to dispose of their cow dung, few would have expected that it would have also resulted in a way to dispose of old bottles as well. J. D. Machenzie of the UCLA School of Engineering's Materials Department found a way to combine these two waste materials to make ceramic planks and bricks. The glass and dung ceramic is like styrofoam in looks and weight, is a good insulator, won't soak up water, won't burn, won't smell, can be painted and glazed, drilled and sawn, and can be glued or nailed together like wood. The mixture is between 5 and 10 percent dried cow dung, and the rest is finely powdered glass. The dung is subjected to a process that reduces it to a fine, black powder, mixed with powdered glass and heated at relatively low temperatures to

produce boards or bricks. Machenzie says density can be controlled so accurately that the final product can be made to either float or sink in water.

Since Pennsylvania cows are superior, we foresee higher quality brick here by this method.

SURVEY ANNOUNCEMENTS

LYTLE APPOINTED AT PITTSBURGH

William S. Lytle has been appointed as Chief of the Oil and Gas Division of the Pennsylvania Geological Survey as well as geologist-in-charge of the Survey's Pittsburgh Branch Office. Bill Lytle succeeds Dr. Dana R. Kelly, who resigned to do oil and gas geology with private industry.

A graduate of the Pennsylvania State University, Bill Lytle is a veteran staff member of the Pennsylvania Geological Survey, with over 25 years of service. Bill is well known to the Pennsylvania oil and gas industry and is the author of a large number of technical publications on oil and gas in various parts of the state. For many years Bill has been the Pennsylvania representative in the Secondary Recovery and Pressure Maintenance Committee of the Interstate Oil Compact Commission. He is also our representative on the Ohio River Sanitary Commission, the National Petroleum Council, and several others.

In recent years Bill Lytle has been working on updating and revising the petroleum reserve calculations for Pennsylvania. Currently, he is also actively participating in the preparation of a stratigraphic framework for the Pittsburgh Regional Environmental Study Project.

We know that under Bill Lytle's direction the Pittsburgh office of the Survey will continue to effectively serve the needs of the oil and gas industry, as well as the citizens of the Greater Pittsburgh area.

KUNKLETOWN QUARTZ LOCALITY OPEN TO COLLECTORS

We have been informed that the quartz crystal locality at Kunkletown is again open to mineral collectors. Permission must be obtained at the plant and a release signed. Collectors must then stop in at the quarry office and show that they have obtained permission.

This operation is now under the ownership of the Universal Atlas Cement Co., Mr. R. E. Miller, P. O. Box 29, Northampton, Pa. Initial permission must be obtained from this address before proceeding to the Kunkletown quarry.

The initiative for re-opening this locality was taken by Universal Atlas. We wish to thank them and Mr. Alton Dorshimer, Foreman at Kunkletown, for their courtesy and understanding. We hope all collectors will cooperate, act responsibly while on the property, and at all times take safety precautions to prevent accidents.

PENNSYLVANIA GEOLOGICAL SURVEY STAFF

Arthur A. Socolow, *State Geologist*
Donald M. Hoskins, *Assistant State Geologist*

ADMINISTRATIVE DIVISION

Shirley J. Barner, *Stenographer*
Linda M. Bechtel, *Stenographer*
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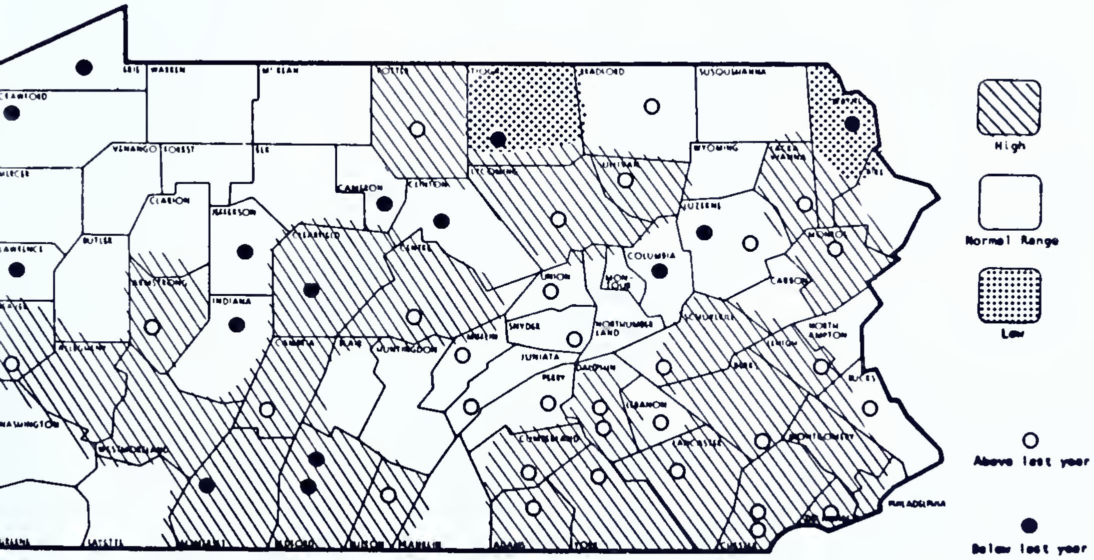

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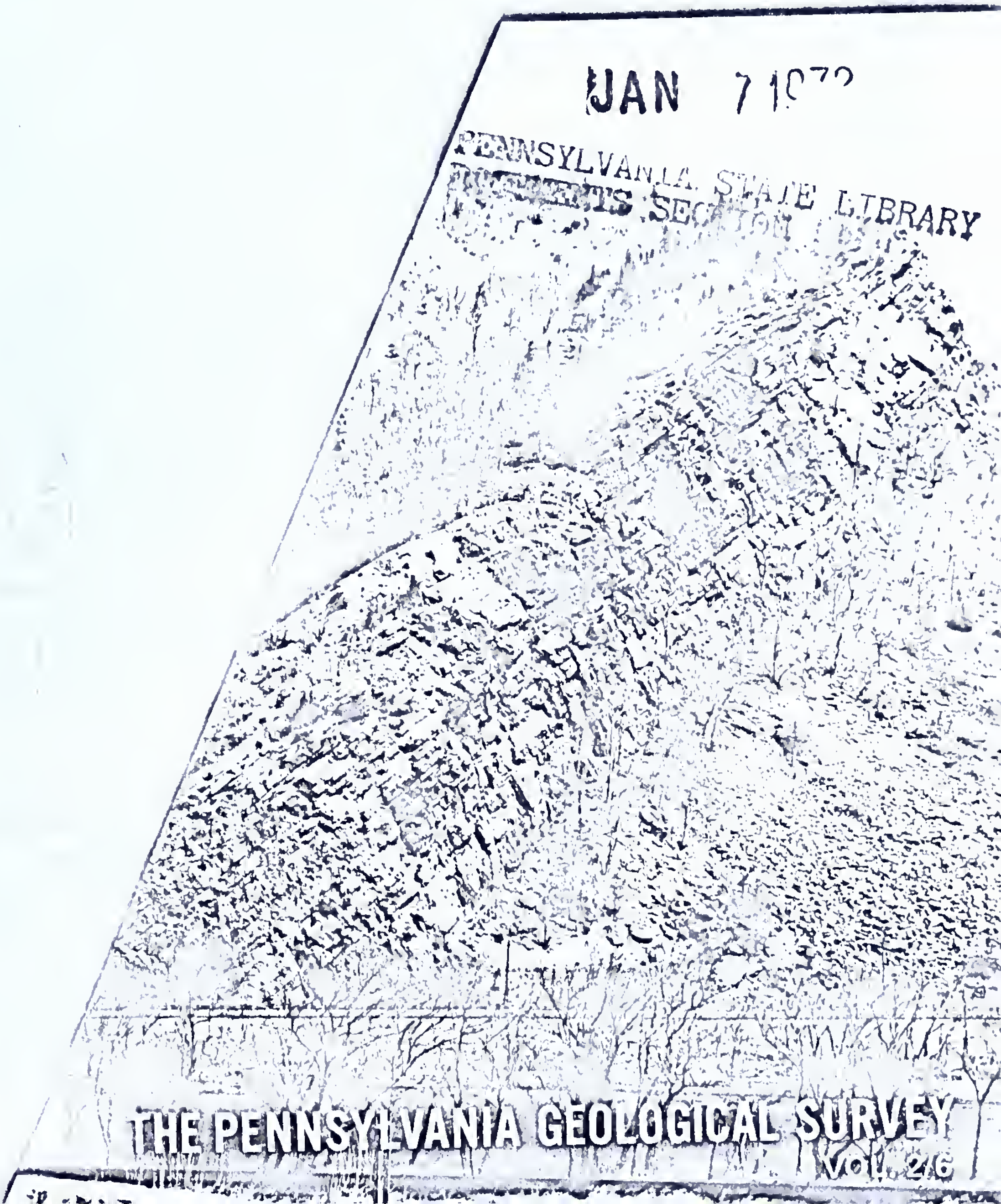

THE PENNSYLVANIA GEOLOGICAL SURVEY

Vol. 2 6

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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DECEMBER 1971

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

MEETING THE CHALLENGE

The Annual Meeting of the Geological Society of America, held in Washington, D. C., this November, was a noteworthy event in many ways. First of all, the record number of over 4300 geologists registered in attendance was a tribute to the scope and quality of the technical program in the face of economic austerity.

Particularly of interest, however, was the emergence of a recognition, even among some of the most technical and scientific sessions, that geologists have a responsibility to provide an input into environmental quality studies, and to do so in a language intelligible to non-geologists. This was really the first time that such a broad-based, national assemblage of geologic scientists, representing government, industry, and the academic community, was clearly challenged to fulfill its obligations, both as scientists and as citizens. Members of Congress, the Executive Branch, and non-geological planners all stressed the need for prompt and adequate reports by geologists to give the decision-makers a sound basis upon which to function.

Some geologists are having difficulty in relating their abilities and their activities to our society, and some still seem to be reluctant. Certainly in a state like Pennsylvania, where very few of man's activities can escape the contact and impact of geology, we geologists have a particular responsibility to share our knowledge and to do so in a format understandable to the users and the decision makers.

The Pennsylvania Geological Survey aims to meet its obligations by striving to adapt its geological investigations and reports to the needs of the community. Our Environmental Geology Division has been rendering prompt and excellent service to state and local government agencies and to Pennsylvania citizens faced with geologic problems. During the past year that division of the Survey has completed 181 environmental geology site evaluations for Pennsylvania Department of Transportation projects, 96 water well site studies for state agencies and municipal authorities, 64 engineering geology studies and 22 economic geology studies for fellow governmental agencies. To this record of service, it should be added that the Pennsylvania Survey in the past year completed and published 21 major geologic and mineral resource studies, and released 210 new detailed topographic quadrangle maps. All in all, the Pennsylvania Geological Survey is very actively striving to meet the contemporary needs of the Commonwealth.

Arthur A. Socolow

UNUSUAL MINERALS FOUND IN PENNSYLVANIA

The occurrence of unusual minerals is of interest from several aspects. The collecting of minerals is a rapidly growing hobby devotedly pursued by many enthusiasts in Pennsylvania. Not only is the discovery of an unusual mineral or crystal an exciting surprise but it also can be a rewarding scientific experience that enlarges our view of our environment. In addition, unusual minerals are of interest to the professional geologist because often they provide critical information about the origin of a rock and about its minor-element composition. Both of these pieces of information are necessary to properly assess the economic potential or environmental significance of a rock formation. For these reasons, the Pennsylvania Geological Survey has a continuing program of mineral identification, much of it aided by the industry and curiosity of mineral collectors. We are grateful to them for sending to us for confirmation unusual mineral finds that otherwise might have escaped our attention.

Several rare and unusual minerals recently have been collected by Mr. Lavere Wolf at the Cedar Hill serpentinite quarry in Lancaster County. The rarest of these is the magnesium-calcium carbonate called **huntite.** This mineral has never before been reported from Pennsylvania and is quite rare elsewhere. The rhombohedral huntite occurs as white crusts on magnesite and deweylite as a result of surface-water alteration of these two minerals. Another excellent specimen found by Mr. Wolf contains large masses and excellently formed crystal books of the mineral **penninite,** a member of the chlorite family. Also in this specimen were small but visible tan crystals of **zircon,** a mineral that is rarely large enough to see with the naked eye. White crystals of **fluorapatite** and black grains of **magnetite** also were present.

From a quarry in Triassic sediments, near diabase. Martin Anne discovered the rare hydrous nickel arsenate **erythrite** and the previously unreported cobalt arsenic sulfide **cobaltite.** This latter mineral is a primary ore of cobalt where it occurs in sufficient abundance. Although only a small amount occurs at the Pennsylvania locality, it is of great interest scientifically for the information this occurrence may yield about the origin of Triassic metallic ore minerals. Consequently, more studies of this occurrence are in progress.

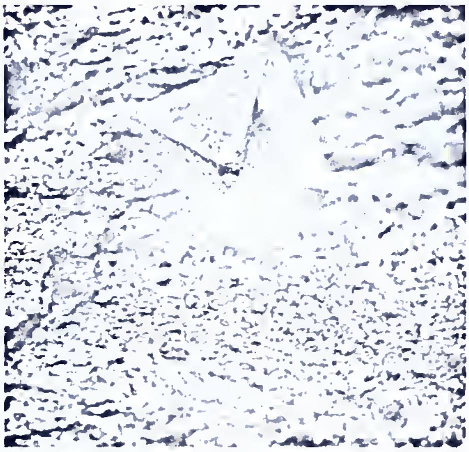
At the Showalter limestone quarry in Blue Ball, Lancaster County, several unusual minerals have been confirmed from samples sent in by James Stauffer and Bryon Brookmyer. The most unusual are pale-yellow crystal plates of **celestite,** a strontium sulfate. This mineral commonly is pale blue to colorless; yellowish crystals have scarcely been reported at all in the literature. Other crystals recently found here include **pale blue celestite,** blue and purple **fluorite, calcio-strontianite** (or perhaps simply strontianite), pink **calcite** crystals, and flesh-colored **dolomite** crystals. Not only do these associated minerals make attractive mineral specimens, particularly for micromount collectors, but they also provide evidence of notable trace amounts of strontium and fluorine in the limestone.

Vein quartz at the Showalter quarry rarely contains a few small needle-like, black to brownish black, wiry inclusions of rutile, a titanium dioxide identified by x-ray diffraction.

Other recent unusual mineral discoveries of interest to both the collector and the geologist include the copper-bearing mineral **chrysocolla** near Hummelstown (by Wayne Downey), the uranium silicate **coffinite** from Jim Thorpe and the complex rare-earth silicate **chevkinite** from near Bethlehem (both by Robert Smith, II), **magnetite crystals** from the Mud Lake limonite pits (by James Stauffer), and **pumpellyite**, a complex alumino silicate of calcium, magnesium, and iron, from the Bunker Hill volcanics near Jonestown (by E-an Zen from petrographic microscope observation).

Several of these identifications have been used in geological publications to clarify the origin of the rocks in which they occur. Others are useful as trace-element guides to possible low-grade metallic mineralization and are thus a potential tool in the search for future extractable mineral deposits. Some of them may influence the composition, and hence the quality, of utilizable surface and groundwater, particularly the soluble carbonates, sulfides, and the arsenate. Finally, we hope that specimens of these minerals and the geological history that they represent will enrich the lives of many collectors in Pennsylvania.

D. M. Lapham
J. H. Barnes



Magnetite crystal in chlorite schist, Lancaster County, magnified two times (photo by Les Chubb).

STATE GEOLOGIST CHAIRMAN OF ACSN

The American Commission on Stratigraphic Nomenclature held its annual business and technical meeting in Washington, D. C. on November 3, 1971. Upon completion of the technical program, officers were elected for 1971-72. Dr. Arthur Socolow, Pennsylvania State Geologist, was elected Chairman, and Dr. Zoltan de Cserna of Mexico was elected Vice Chairman and Secretary of the American Commission on Stratigraphic Nomenclature.

LANDSLIDES AND ROCK FALLS, PITTSBURGH AREA

Recorded landslides and rock falls in the Pittsburgh area for 23 years indicate that five slides per year result in average damages of $11,500 and 0.3 injuries or deaths per slide or fall. Many slides are unrecorded and one can readily double the number of occurrences. A conservative estimate of average damages is over $100,000 and three injuries or deaths per year from these hazards. This figure excludes costly delays and modifications of construction in progress when slides or falls occur.

Recorded data from 110 landslides and rock fall sites have been compiled by engineering firms and researchers. Reconnaissance geological investigation of a half dozen publicized slides and falls occurring in the past two years was made by Dr. Dana R. Kelly (formerly of the Survey) immediately after or during slide movement. The slides are associated primarily with red and variegated mobile clay and clay-shale zones of the Pennsylvanian Conemaugh Group which crop out in the hilly Pittsburgh area. Understanding of basic geology is the prime requisite in anticipation and prevention of these failures.

An unpublished report on the basic geological factors in landslides and rock falls of the Pittsburgh region by Dr. Kelly and the above mentioned half dozen geological investigations are on open file in the Survey's Pittsburgh office. An open file report may be reviewed at the office where it is filed and may be copied at the expense of the reviewer.

William S. Lytle

Home being crushed by toe of slide, along Route 28 near Millvale.

NEW COAL REPORT ON WASHINGTON PA., AREA

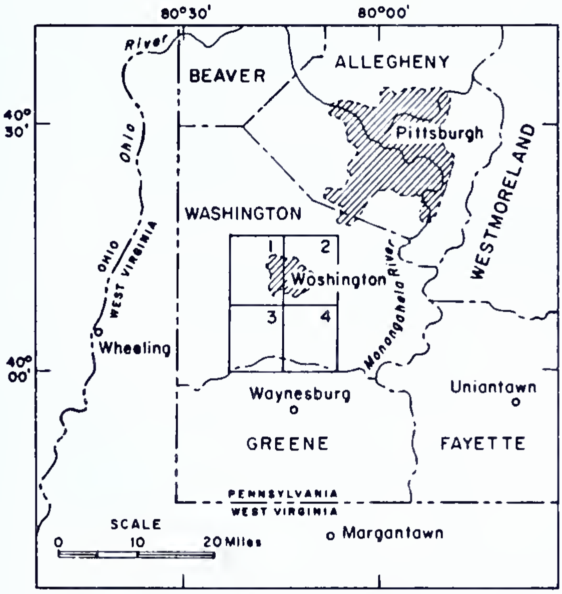
The U. S. Geological Survey has recently released an important new publication entitled "Coal-bearing Upper Pennsylvaniana and Lower Permian Rocks, Washington Area, Pennsylvania" (Professional Paper 621).

The 320-square-mile area covered in this report lies immediately south of expanding Pittsburgh residential-industrial complex, and, in addition, is in the heart of Pennsylvania's most important and productive coal field. It is difficult to exaggerate the importance of sound geologic information in dealing with the manifold questions which are certain to arise as this area is urbanized. Complex and interacting problems of water supply, waste disposal, water pollution, coal mining, and construction stability are all intrinsically bound up in the geology of the area.

The report includes extensive discussion of the various rock-types occurring in the Washington area, as well as information on coal and other mineral resources, engineering geology, and hydrology. Large scale, multicolor maps permit users to readily determine the nature of the rocks at any point at the surface or in the sub-surface throughout the area.

Without doubt, this report will be the principal source of geologic information needed in the rapidly developing Washington area, and forms an effective companion piece to similar reports published by the Pennsylvania Geologic Survey on the area immediately to the east.

Professional Paper 621 may be obtained for $6.75 from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.



Location of the Washington area, Washington and Greene Counties, Pa. Quadrangles included in report: 1, Washington West; 2, Washington East; 3, Prosperity; 4, Amity.

TRACE ELEMENTS IN COAL – POTENTIAL ECONOMIC SOURCES AND HAZARDS

Many trace elements, some quite scarce in other rocks, are known to occur in coal and coal refuse. In recent years two major aspects have come under scrutiny: the possibility that coal, or coal refuse, may be a future source of scarce trace elements and the pollution effects of some of these elements as they enter the air and water circulation systems. A recent survey of existing literature by the Pennsylvania State University (Special Research Report SR-83, 1971, by S. C. Sun, H. Vasquez-Rosas, and D. Augenstein) and identification of the products from burning coal mines and culm banks by the Pennsylvania Geological Survey contribute to our understanding of these two aspects of coal chemistry.

The major and minor elements in the inorganic fraction of coal are well known; chiefly silica, alumina, iron (ferric) oxide and calcium (largely as a carbonate or sulfate) with minor magnesium, titanium (0.5 to 2.5%), alkalies, and sulfur (largely as pyrite and sulfates). The abundance and distribution of the other elements, the trace elements, is less well known. In fact, for many such elements there are no adequate data for the coals in Pennsylvania. Some are of economic interest or are potential pollutants and their concentrations can only be inferred from coal studies elsewhere or from very scattered sample analyses. Among those for which more data on Pennsylvania coals are desirable are antimony, bismuth, the halogens (iodine, fluorine, chlorine), mercury, rubidium, selenium, thallium, uranium, zinc, and zirconium.

At some localities and for some coals, the factor of trace element enrichment over that for average crustal rocks may be 100 times or more; for example, for beryllium boron, scandium, germanium (up to 2800 times), arsenic, and perhaps yttrium, silver, and gold (Sun and others, p. 5). The coals of the northern Appalachians, compared to other domestic coals, are the richest in beryllium, copper, and yttrium and notably enriched also in cobalt, gallium, lanthanum, and nickel. Some data for Pennsylvania coals are presented in the accompanying table, taken from the summary by Sun and others, largely from anthracites.

Selected Trace-Element Composition of Pennsylvania Coals

Element	Range (%)
Arsenic	.002-.01
Berylium	.0001-.009
Chromium, anthracite	.001-.01
Chromium, bituminous	.01-.03
Cobalt	.001-.009
Copper	.001-.07
Germanium	.009-.015
Lead	.001-.01
Molybdenum	.001-.009
Nickel	.01-.09
Tin	.01-.09
Vanadium	.01-.02

As can be seen from the table, several elements exhibit a rather high concentration and the possibility of their extraction as processed by-products or collected from air or water filtering systems is of sufficient interest to merit further investigation. Among those for which there is little data, new techniques of mercury analysis may soon give us more information on this element that, as a water pollutant, can be so hazardous to health. The halogens too merit investigation from this standpoint. The Pennsylvania Geological Survey recently has identified compounds containing chlorine and fluorine from areas of burning anthracite beds. These halogens, carried in the air along with sulfur, can be powerful corrosive agents and also hazardous to health. Recently the Survey also has found lead, arsenic and selenium associated with burning anthracite. The latter two are not only rare commercial elements, but when compounded may become dangerous pollutants as well. Thus, it is clear that although research is underway by many investigators much remains to be done in Pennsylvania, particularly for detailed data at specific localities, both with regard to future resources and to the improvement of the quality of our environment.

D. M. Lapham

PENNSYLVANIA GRADE LUBE OIL DEMAND IS UP

Refinery capacity for Pennsylvania Grade crude oil is at present 42,000 bbls. per day. Completion of refinery remodeling and a new 10,000 bbls./day refinery going on stream will increase the present capacity 15,000 bbls./day to a total to 57,000 bbls./day by the first of 1972. This represents less than 1 percent of the total refinery capacity of the United States. Yet, the lubricating oils refined from Pennsylvania Grade crude commands 15 percent of the lubricating market in the United States.

National sale of lubricating oil has been growing at the rate of 1 to 2 percent a year; whereas sale of Pennsylvania Grade lubricating oil has grown 40 percent in the last 5 years, or an average of 8 percent per year for 5 years.

There is money in the lube oil business. The National average for the amount of lubricating stock in a barrel of crude oil is 2 percent. For Pennsylvania Grade crude it is normally 30 percent, while the new East Canton field of Ohio averages 35 percent. The high percentage of lube oil in a barrel of this crude is why Pennsylvania Grade crude sells at a premium price, and it is in such high demand because it is one of the best lubricating oils generally available.

PEAT IN NORTHEASTERN PENNSYLVANIA

"Peat Deposits of Northeastern Pennsylvania" has been issued by the U. S. Geological Survey as Bulletin 1317-A. Authored by Cornelia C. Cameron, this 90-page report deals with peat resources in portions of 10 counties: Monroe, Luzerne, Columbia, Wyoming, Pike, Wayne, Lackawanna, Susquehanna, Sullivan, and Bradford.

Peat resources in a 900-square-mile area in northeastern Pennsylvania are estimated at more than 13 million short tons of air-dried peat, chiefly of good quality reed-sedge type. Most deposits are 10 to 100 acres in extent, average 5 to 16 feet in thickness, and contain from 10,000 to 100,000 tons of potential resources. Individual mining operations are relatively small but require minimum facility investment. Accessibility to operation sites and to markets is good.

Ninety-five peat deposits in the Appalachian Mountains of northeastern Pennsylvania were studied. These represent various geologic settings related to structural control of bedrock and to differential erosion. Physical and chemical analyses of samples show that specific characteristics of the peat can be related to distribution of bedrock and unconsolidated material surrounding each deposit and to the size and position of the drainage basin. Ash content, water-holding capacity, and fiber size reflect the form and the kinds of material of the depression walls and of the surrounding drainage basin.

Bulletin 1317-A, "Peat Deposits of Northeastern Pennsylvania" is available for $0.45 from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

This new report supplements another recent peat report, Information Circular 65, Peat Bog Investigations in Northeastern Pennsylvania. This comprehensive report emphasizing the economic potential for peat development is available for $0.85 plus tax from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125 (check payable to Commonwealth of Pennsylvania).

Peat bog in Monroe County being excavated for peat.

"Wood" Opal

Siderite Concretion "Blossom"

(Photos by Les Chubb)

ROCKS AND FLOWERS

Heretofore, horticultural pursuits have not intruded themselves upon the rock-bound world of the Pennsylvania Geological Survey. That isolation came to an abrupt end on September 22 when we were invited to participate in the 25th annual Garden Show at Linglestown. Our first thoughts came up with things like rose quartz, barite roses, and perhaps even cabbage-head quartz. However, this was not exactly what the show sponsors had in mind. It seems that natural rock and mineral specimens are beginning to command a significant interest as integral parts of floral displays. If chosen with imagination, rock specimens not only simulate the natural flower habitat, but they also may enhance the artistry of the display. Not being artists at this sort of thing, we decided to provide the show with a variety - 26 different rock and mineral samples, all of which could easily be collected in central Pennsylvania. The wide range of textures, shapes, and colors did seem to stimulate interest among the show visitors. Perhaps the moral of this venture is that if you don't want to collect rocks for their own sake, collect them for your flowers and for the fun of devising creative arrangements.

255 PENNSYLVANIA MINERALS

When Professor Arthur Montgomery, Lafayette College, up-dated Samuel Gordon's "Mineralogy of Pennsylvania" in "The Mineralogy of Pennsylvania: 1922-1965" he listed 237 verified mineral species. Since that publication, at least 18 new minerals have been descibed, bringing the total to at least 255. Of the total (66) added to Samuel Gordon's original list of 1922, 18 were first described in publications of, or first verified by, the Pennsylvania Geological Survey. All together, in the world there are more than 2000 described mineral species so that a total of 300 for Pennsylvania is not an impossible dream.

PRESERVING PENNSYLVANIA'S FOSSIL AND MINERAL LOCALITIES

On November 6, 1971 a group of 44 mineralogists and club representatives from all over Pennsylvania met in the William Penn Memorial Museum to discuss a series of related problems that repidly are becoming acute. Mineral and fossil collecting has had a long and distinguished history in this state. Not only have unusually fine specimens been plentiful, but many world-famous scientists have described new species from Pennsylvania or studied unusual geological environments of the past in which the minerals formed and the plants or animals lived. Such materials have become type specimens and the localities studied have attained world-wide recognition.

Today, many of these localities and specimens from them are in danger of extinction. The press of progress is taking its customary toll. A few localities that were originally poorly described ("500 feet north on a line between the large oak and Jethro Snyder's barn") are lost. Many more have become lost by the encroachments of an expanding urbanization - housing developments, shopping centers, and industrial complexes. Some have suffered an ignominous demise by suffocation - trash and garbage fill sites. Still others have been trucked away and have become a part of our network of macadam and concrete highways. In our need for space and for materials, mineral and fossil localities have been the losers, and the trend is accelerating. Not only are scientifically important localities becoming inaccessible, but the ever-expanding group of collectors have, in the augmentation of affluence and leisure time, found it more and more difficult to pursue their hobby. Furthermore, industrial quarry operators have not always been pleased with this new influx of visitors rooting around in dangerous places and not infrequently disrupting their working activity.

What can be done to protect the future of collecting and study in Pennsylvania? Data must be gathered on all existing sites and proposals for preservation sought and implemented. These are the goals of the recently formed "Commission For The Preservation Of Pennsylvania Mineral And Fossil Sites". The first conference, chaired by Professor Raymond Grant of Lafayette College and addressed by Dr. Davis M. Lapham, Chief Mineralogist of the Pennsylvania Geologic Survey, was a resounding success. Specific problem areas were focused upon, solutions discussed, and investigations begun. Assistance from "The Friends Of Mineralogy", state agencies, colleges, universities, museums, and mineral clubs will give this endeavor a broad-based spectrum of support with, we hope, the enthusiasm and know-how to accomplish its difficult but worthwhile goals.

D. M. Lapham

AGES OF ROCKS IN PENNSYLVANIA

Lately, with respect to moon rocks, we have heard much discussion about the subject of geochronology – the subject that deals with the age of a rock obtained by measuring radioactive decay products. Many in Pennsylvania are interested in this subject. We frequently are asked, "What is Pennsylvania's oldest rock?" (Answer: probably older than 1,100,000,000 years.). Or we may be asked where Pennsylvania's oldest rock can be found (south or west of Philadelphia) or the age of a rock at a specific locality. In addition, many of today's students and geologic researchers are faced with the problem of interpreting the many radiometric dates in terms of past geologic events.

A new Pennsylvania Geological Survey publication, Information Circular 70, entitled "Summary of Isotopic Age Determinations In Pennsylvania" by D. M. Lapham and S. I. Root, attempts to answer these questions. This publication summarizes all data available through 1969 which pertains to age dating and age interpretation in Pennsylvania. The geological significance of the more than 75 determinations is emphasized in brief discussions of each geologic province. Ages have been found to fall into six major groups between 1100 million and 190 million years ago, indicating major events that re-set our radioactive time clocks. These data help to clarify Pennsylvania's complex and interesting geological history.

This publication is available for $0.85 plus 6% state sales tax for Pennsylvania residents from The Bureau of Publications, 10th and Market Streets, Harrisburg, Pa. 17125.

SOLID WASTE SESSION TO MEET IN PHILADELPHIA

This year, the annual meetings of the American Association for the Advancement of Science (AAAS) will be held in Philadelphia from December 26 to December 31, 1971. There will be a full program of papers and symposiia on time topics of current scientific research and advances.

A highlight of the AAAS meetings will be a full-day symposium on December 29th on "Geologic Implications of Solid Waste Landfill." This is a subject of great interest in the light of present-day attention to maintaining the quality of our environment while disposing of our mountains of wastes.

The speakers on the symposium come from all parts of the country. Pennsylvania's leadership in this field of research is demonstrated by the participation of Professors R. R. Parizek and Donald Langmuir of the Pennsylvania State University, G. L. Merritt and W. C. Bucciarelli of the Department of Environmental Resources, and Grover Emrich, geologic consultant. Pennsylvania Geological Survey Director, Arthur Socolow, is the organizer and moderator of the symposium.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax. For free publications write to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania.

Publications		*Price*
A 119	**Geology and mineral resources of northeastern Franklin County** by S. I. Root, (104 p., 51 figs., 2 pls.)	$3.85
A214C	**Surficial geology of the East Stroudsburg 7½ minute quadrangle, Monroe County, Pennsylvania** by Milena F. Bucek, (40 p., 12 figs., 1 pl.)	2.65
G 56a	**Geology and land use in eastern Washington County (California and Mongehela quadrangles)** by B. H. Kent and others, (2 pls.) (text was published in G 56.)	2.25
IC 70	**Summary of isotopic age determination in Pennsylvania** by D. M. Lapham and S. I. Root (29 p., 1 fig.)	0.85
PR 183	**Oil and gas developments in Pennsylvania in 1970** by W. S. Lytle and others; (50 p., 16 figs.)	0.95
W 28	**Hydrology of the Pleistocene sediments in the Wyoming Valley, Luzerne County** by J. R. Hollowell (77 p., 16 figs., 4 pls.)	5.40
W 29	**Summary of groundwater resources in Montgomery County,** by T. G. Newport (83 p., 14 figs., 2 pls.)	2.10

EARTH SCIENCE TEACHERS' CORNER

science theater

At the 1971 Geological Society of America annual meeting, several excellent films were shown. Some of these, are listed below; contact the listed producer for the conditions of availability.

HEARTBEAT OF A VOLCANO (20 minutes)

This film of the 1969-70 Kilauea eruption contains good, often spectacular, coverage of Hawaiian volcanic activity. Overall perspective of the eruption is weak, but lava-falls, vents, fountains, and flows speak well for themselves.

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611

SUCCESSION ON LAVA (14 minutes)

The step-by-step return of plant and animal life to areas overrun by basalt lava is well photographed on flows of different ages on Hawaii's Kilauea Volcano. The cycle begins again as new flows sweep through dense jungle.

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611

THE DRIFTING OF THE CONTINENTS (45 minutes)

Bullard, Runcorn, Cox, Vine, and many others describe, in simple terms and with excellent use of graphics, the contributions of their specialty to the new global tectonics. A thorough, clear summary of this geological revolution A BBC production.

Time Life Films
43 West 16th Street
New York, New York 10011

DEEP SEA DRILLING PROJECT (28 minutes)

A fast-moving account of the first 3 legs of the Glomar Challenger drilling program. Shipboard activities are shown by imaginative camera work; the concept of sea-floor spreading is captured by unusually effective animation. Split-screen images in the "Woodstock" tradition.

Association-Sterling Films
866 Third Avenue
New York, New York 10022

THE AGING OF LAKES (14 minutes)

All lakes age and die, but the end comes sooner when man's carelessness causes an increase in the influx of sediment and dissolved nutrients. The concept of eutrophication is well explained. A crisp, informative film that "tells it like it is."

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611

THE RISE AND FALL OF THE GREAT LAKES (17 minutes)

A lone canoeist rides out the Quaternary ups and downs of the lakes, from the top of an ice cap to the bottom of a flooded reservoir. His oftimes humorous encounters effectively convey concepts of recent geological change, but it's not so funny when he ends up with a mouthful of man-made scum.

National Film Board of Canada
Suite 819
680 Fifth Avenue
New York, New York 10019

AN APPROACH TO THE PREDICTION OF EARTHQUAKES (27 minutes)

Model studies and lab tests are effectively used to explain seismic fundamentals, and modern tools of Japanese geophysical research are shown in use during the remarkable Matsushiro earthquake swarm of 1966.

American Educational Films
331 North Maple Drive
Beverly Hills, California 90210

SAN FRANCISCO: THE CITY THAT WAITS TO DIE (58 minutes)

San Francisco and the Geological Survey's National Center for Earthquake Research star in this dramatic, hard-hitting BBC production that demonstrates both the progress of modern seismology and the continuing human blindness toward real earthquake dangers. An informative and powerful film despite minor errors in the narrative.

Time Life Films
43 West 16th Street
New York, New York 10011

CONTROVERSY ON THE MOON (15 minutes)

"Volcanic" Jack Green and "Impact" Gene Shoemaker trade punches on the origin of specific lunar features. Good use of models and photographs of both lunar features and terrestrial analogs.

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611

MARINER/MARS (21 minutes)

This film, produced by the Jet Propulsion Lab, presents an interesting summary of Mars exploration to date. No advertising.

NASA Goddard Space Flight Center
Photographic Branch Code 253
Greenbelt, Maryland 20771

SURVIVAL IN THE SEA (28 minutes)

Beautiful underwater photography emphasizing the food chain of the sea. Big fish eat little fish, and the techniques of attack, defense, and camouflage are well shown in this award-winning film.

Contemporary Films/McGraw-Hill
330 West 42nd Street
New York, New York 10036

SURVEY ANNOUNCEMENTS

NEW ANNUAL OIL AND GAS REPORT

The Pennsylvania Geological Survey has published Progress Report 183, "Oil and Gas Developments in Pennsylvania in 1970". This annual summary of new activities and developments will be of interest to all concerned with oil and gas production in Pennsylvania. It's particularly timely in view of the great interest in adequate gas supplies for the Northeast, as well as the great spurt in exploration activity in the New York-Pennsylvania border region.

The new report is divided into three parts: Part 1, Completion Highlights for 1970; Part 2, Oil and Gas Activity in 1970; Part 3, Summarized Records of Deep Wells Reported in 1970.

A significant deep test, the #1 Nellie C. Martin in Armstrong County, became an Oriskany (Lower Devonian) discovery in the former no sand area, after finding the upper part of the Cambrian dry at 15,574 feet and plugging back to the Oriskany. Another Oriskany discovery in this county was made on the Roaring Run Anticline.

Oil production and reserves decreased 10 and 7 percent, respectively during the year, while gas production decreased 2 percent and gas reserves increased 6 percent. The production histories of several highlight oil and gas wells that were drilled in 1968 are shown in graphic form.

The Maraflood project in the Bradford Field, McKean County, was expanded and another Maraflood project in the Venango Sandstone was started in Warren County.

Progress Report 183 may be purchased from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125 for $0.95 plus sales tax.

CORRECTION: PENNSYLVANIA RANKS HIGHER IN ZINC

In the October, 1971, issue of PENNSYLVANIA GEOLOGY, the article on Pennsylvania Mineral Industry Growth stated that the Friedenville Zinc Mine in Lehigh County produced 1% of all zinc mined in the United States last year. We goofed; Arnold Willman, New Jersey Zinc Company's Resident Geologist at that mine, points out that on the basis of the U. S. Bureau of Mines' statistics, the Friedensville mine ranks as the second largest zinc producing mine in the United States, producing nearly 7% of the total United States zinc production.

We're pleased to set the record straight and proud of our ranking position in such a vital industrial and strategic commodity as zinc.

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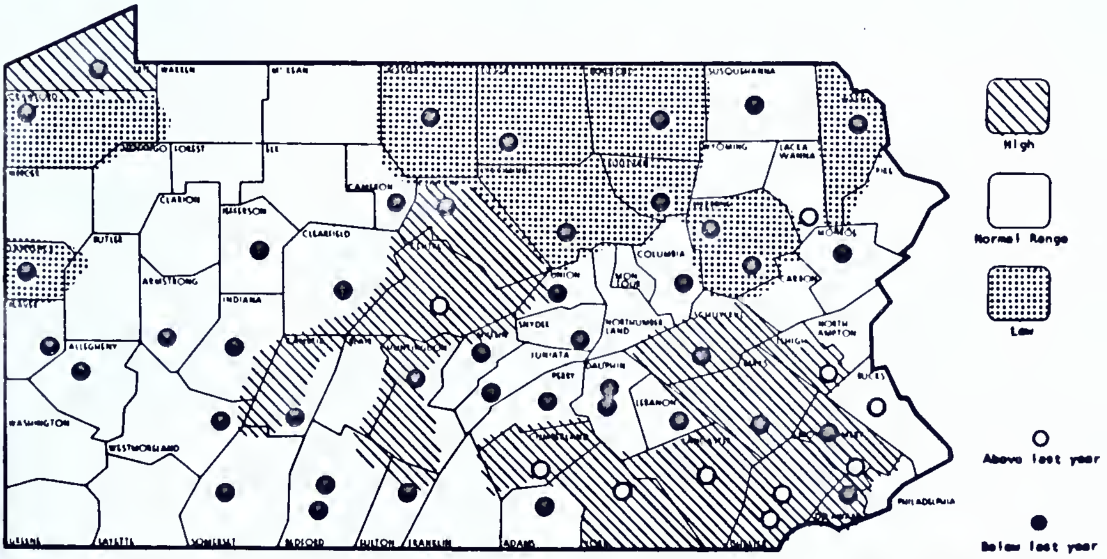

HAPPY NEW YEAR

PyG345.17/4
1972
Vol.3, No. 1

PENNSYLVANIA GEOLOGY

MAR 13 1972
PENNSYLVANIA STATE LIBRARY
DOCUMENTS SECTION

THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER – Slate quarry in Northampton County, typical of the mineral operations now under jurisdiction of the "All Surface Mining Act." (See article this issue).

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

FEBRUARY 1972

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

MORE THAN LIMITED INVOLVEMENT

Recently when the American Association for the Advancement of Science met in Philadelphia, a member of the audience approached me after the session I chaired on Geology and Solid Wastes. He expressed his surprise that geologists were so involved with this "public problem" of waste disposal. Further conversation brought out the fact that this man, a non-geological scientist, had the concept that geologists are concerned primarily with mineral deposits and in some more abstract way with rocks. This is not an isolated concept, and yet so very far from reality, particularly in the functions of a state geological survey.

A partial review of some of our Survey services and involvements in just the last few months may help dispel this restricted concept of geology: A proposed reactor site required our environmental commentary. The proposed subdivision of a suburban landsite brought us the question of feasibility of on-site sewage disposal. A mine drainage court case posed the problem of the origin and route of acid underground waters. Expansion of a state college campus gave us the task of locating a high-yield well site. An urban landslide condition called for immediate recommendations to alleviate the problem. The spillage and underground movement of gasoline required designation of best recovery well sites. A federal study of river basin development needed our data on groundwater utilization. A municipal authority faced with a sinkhole cavein called for guidance on the nature of the problem. A major industrial concern faced closure unless a specific type of geologic environment could be found to handle disposal of a problem waste product. Our highway colleagues call for geologic impact evaluations of their individual projects. A condemned landfill operation required prompt geologic assessment of an alternate site. A proposal to dispose of liquid waste into the underground required evaluation of where it would go and what harm it might do. The developing State Water Plan calls for us to prepare basin-by-basin groundwater evaluations across the state. A church wants to add a wing and match the existing building stone. Municipal officials needed advice on the hazards of blasting over limestone terrain. A pipeline company needed to know of potential mine subsidence problems along a proposed route. A foreign metallurigical company asked for some of our clay for research work. One farm owner wanted to know how close an oil well would be permitted to his property line, and another farmer needed to know if he had sufficient underground water for irrigation. A space-research lab asked for some of our Pennsylvania iron minerals which are reputed to be similar to material on Mars. To evaluate the feasibility of a high-speed transportation route, we were asked for the roadbed and tunneling conditions. And there have been the hikers, the fossil collectors, the school children, the Scout leaders, who all want to know what to find and where to go, and we're glad to tell them.

The above is far from a complete representation of our diverse activities but hopefully, it may dispel the limited concept of geologic involvements.

Arthur A. Socolow

THE NEW "ALL SURFACE MINING ACT"

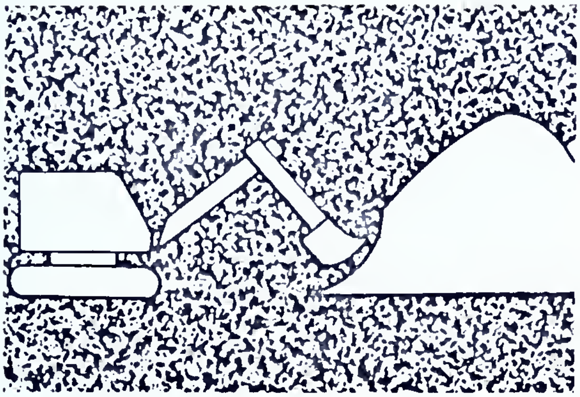
On January 1, 1972, there came into effect a new Pennsylvania law with profound impact upon the mineral industry of the Commonwealth. This is the so-called "All Surface Mining Act", passed by the last session of the State Legislature and signed into law November 30, 1971.

The new "All Surface Mining Law" (Act 147 of 1971) extends the provisions of "The Bituminous Coal Stripping Law," to the surface mining of anthracite and all other minerals. The new act further provides for mine conservation inspectors, imposes powers and duties on the Secretary of Environmental Resources, changes the name of the Bituminous Coal Open Pit Mine Reclamation Fund to the Surface Mining Conservation and Reclamation Fund, declares certain conditions to be nuisances, provides for payments in lieu of bond in certain cases, provides for penalties, and makes numerous editorial changes in the old "Bituminous Law."

The official short title of Act 147 (1971) is "Surface Mining Conservation and Reclamation Act." This act provides for the conservation and improvement of areas of land affected in surface mining of bituminous and anthracite coal, metallic minerals, and nonmetallic minerals of Pennsylvania. It is the intent of this law to aid in protection of wildlife, to enhance land values for taxation, to decrease soil erosion, to aid in the prevention of pollution of Pennsylvania's water resources, to prevent and eliminate hazards to health and safety, to prevent combustion of unmined coal, and generally to improve the use and enjoyment of surface-mined lands.

Basically, Act 147 (1971) is a reclamation law applying to that segment of the minerals industry engaged in recovery of mineral resources by surface extraction methods. The act broadly spells out the guidelines as to how the mineral deposits are to be recovered and how the mined-out lands are to be reclaimed. The act assigns to the Secretary of Environmental Resources the powers and duties of implementing the law by establishing a set of regulations.

For anyone, individual or corporate, to engage in surface mining in Pennsylvania under the new act, he must be licensed by and obtain a permit from the Department of Environmental Resources. As a part of each application for a permit to surface mine, the licensee must furnish (in duplicate): (1) A map showing the boundaries of the proposed land affected (with specific notations on drainage, utilities, houses, buildings, etc.) and related information prepared and certified by a registered professional engineer or registered surveyor; (2) A complete and detailed plan for the reclamation of the land affected, covering some 10 specific items outlined in the law as the minimum criteria to be considered in the reclamation plan. Some of the geologic aspects that may be included in the permit application are geologic cross sections, test-boring information, nature and thickness of mineral seam as well as overlying and underlying strata, and recommendations related to handling surface water as well as those encountered in the mining area.



The information in the permit application is to be reviewed and field checked by authorized persons designated by the Secretary of Environmental Resources and approved as submitted or returned to the applicant with suggested modification (for reconsideration) or reapplication for a surface mining permit.

After successfully obtaining a permit for surface mining, and once such activities are begun on the "permitted" land, periodic progress reports by the operator to the Department of Environmental Resources and on-the-site inspections by the district mine conservation inspector are required by the act.

In Section 3, Definitions, of Act 147 (1971), in the definition of surface mining is listed those operations exempted under the act.

While the act applies to all surface coal mine operations regardless of size or use, it excludes non-coal mineral operations by a landowner for his own non-commercial use, and also excludes small non-coal commercial operations which produce less than 500 tons per acre of mineral product per year. Also excluded are borrow pits for highway construction purposes where the work is performed under bond, contract, and specifications for reclamation comparable to the new act.

Act 147 (71) is a comprehensive law written with the intent of outlining in "flow-sheet" form the sequence of events and responsibilities starting with the individual's wish to surface mine a specific piece of land when he applies for a mining permit, to the concluding act of restoring the mined-out land to its highest and best use condition.

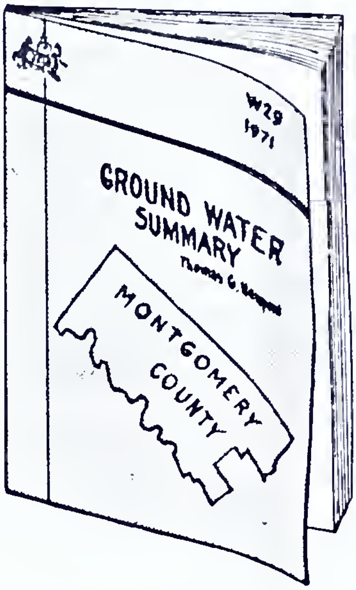
The "All Surface Mining Act" is intended to help preserve the quality of our environment for the benefit of society as a whole. The mineral industry, long a keystone or our society, is being called upon to make a new and greater contribution to this effort.

GARBAGE ROAD

Composted household refuse is being tested for road paving. A test section of road, installed at Westinghouse's Research and Development Center, Pittsburgh, has just passed its first 12-month test with flying colors. The road material is reported to be as durable as asphalt and more resistant to cracking. The mix contains 5 percent compost in addition to asphalt, sand, and crushed stone. The project is part of a program aimed at discovering uses for solid waste materials.

NEW COUNTY GROUNDWATER SERIES — MONTGOMERY COUNTY REPORT ISSUED

With the continuing growth of our population and the expansion of our industries, there is an ever-increasing rise in demand for quality water supplies. Ground water, or subsurface water, constitutes one of the largest reserves of quality water available for development in Pennsylvania. Each year more and more of this subsurface water is being utilized in the Commonwealth oa over 20,000 new wells are annually brought into production.



The development of new wells calls for guidance to help locate favorable sites for the new wells. Almost forty years ago the Survey initiated its groundwater services with a series of regional reports (Bulletins W1 - W6) summarizing the groundwater conditions for each of the six major regions of the Commonwealth. Those bulletins have served well and continue to be valuable aids. However, over the past thirty years the Survey has accumulated a wealth of new groundwater data based on detailed aquifer studies as well as tens of thousands of individual well records accumulated at the Survey. Precise measurements were made in the field and laboratory and answers to many specific hydrogeologic questions were found.

To bring the benefits of new studies and new data to the users of groundwater in Pennsylvania, the Survey decided to prepare an up-to-date summary of groundwater conditions for each county. The county unit was chosen as one with which Pennsylvanians readily identify, while it also results in a more detailed, local framework of groundwater conditions than the earlier regional reports.

The Pennsylvania Survey has now released the first of the new county groundwater summaries, Bulletin W 29, **The Groundwater Resources of Montgomery County**. This report gives the geologic framework and the water-yielding characteristics of each rock formation in the county. Production data is tabulated for over 800 wells with chemical analyses for 121 wells. Detailed maps and tables enable the reader to zero in on groundwater conditions at any given locality in the county. This report will aid planners, property owners, and well drillers of Montgomery County to plan for the efficient development of the groundwater resources.

Bulletin W 29, **Groundwater Resources of Montgomery County,** is available for $2.10 plus tax from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

WATER WELL RECORDS

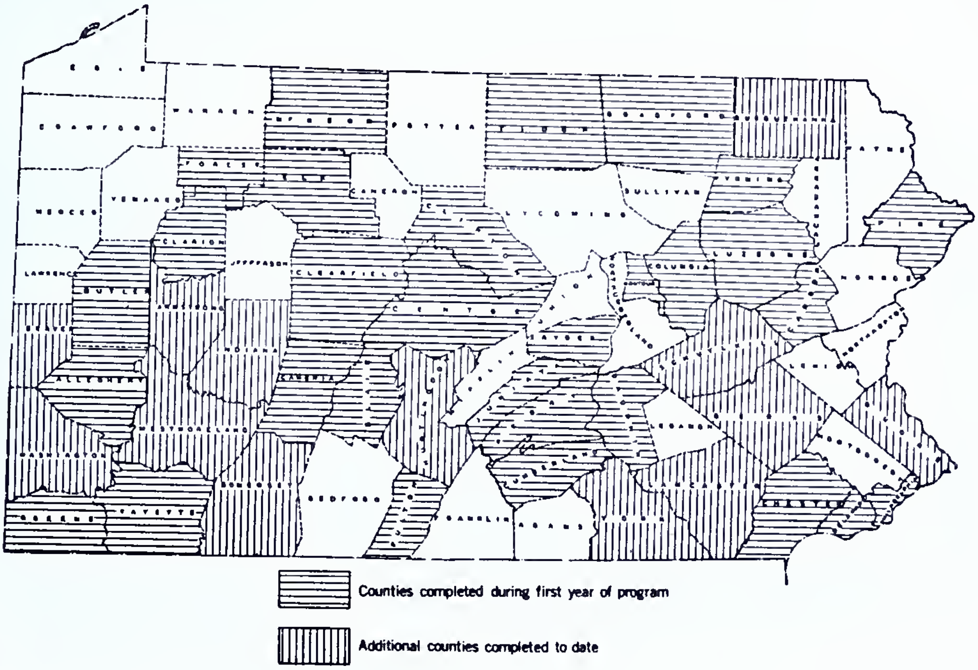
In the April 1970 issue of **Pennsylvania Geology** the Topographic and Geologic Survey first reported on a new program to translate water well drillers' well-completion cards into a computer data retrieval system. This endeavor has enabled the Survey and many others to utilize the vast amount of valuable water well subsurface data in Pennsylvania. Primarily this information has been used to identify the location and the amount of one of Pennsylvania's most valuable resources—ground water.

The index map indicates the 30 counties completed during first year of program. Today, the Geologic Survey has accomplished keypunching thousands of additional water well records and the index map shows the additional 13 counties completed to date.

For a per-page fee of $0.05 computer printout sheets are available from the Survey's Harrisburg office. Within a county, the wells are listed by townships in alphabetical order. Specific hydrogeologic information such as drainage basin, sub-basin, topography of well site, major and minor aquifers, yield of each aquifer, yielding zones within an aquifer, as well as a complete mechanical description of each well are included.

In recognition of the growing demand for ground water and information on its location and amount, as well as a growing concern over water pollution, the Pennsylvania Geological Survey will continue to add water well information to its computer retrieval system so as to expand its ground water services to Pennsylvania citizens.

Alan R. Geyer

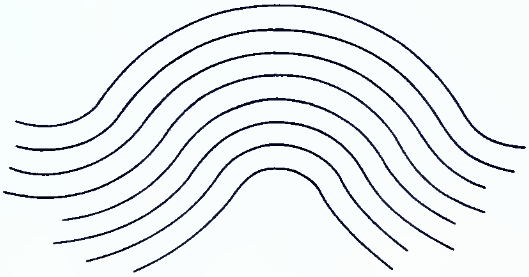


▤ Counties completed during first year of program

▥ Additional counties completed to date

KINK BAND FOLDING IN CENTRAL PENNSYLVANIA - II.

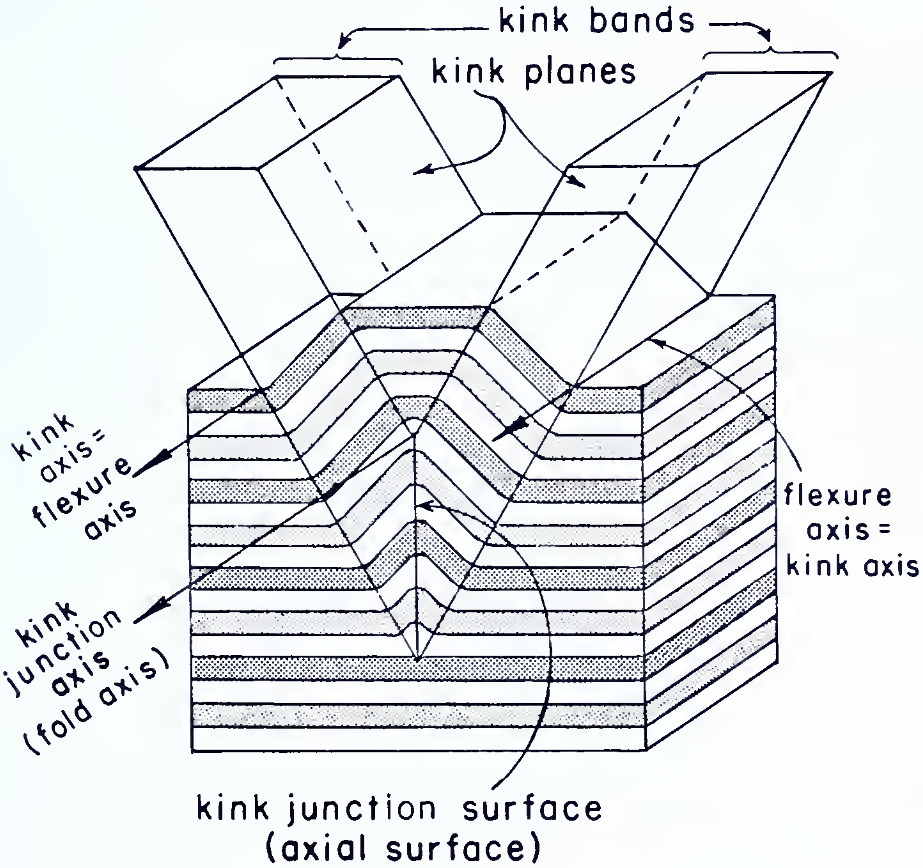
The folds in the Valley and Ridge province in central Pennsylvania have long been considered by some to be simple, parallel folds, similar to the type called concentric fold (Fig. A). In such folds, the beds are uniformly bent over the entire width of the fold, producing a geometry of concentric circular arcs. A consequence of this geometry is that the dip of bedding increases progressively away from the fold crest. In the past ten years, it has been recognized that many of the Valley and Ridge folds do not possess this concentric geometry, but a quite different one similar to that of chevron folds (Fig. B). Throughout each limb of the fold, the bed attitude is constant—the change in bed attitude from one limb to the other occurs within a relatively narrow zone, called the fold hinge. The bending of the beds has occurred only within the narrow hinge. In the limbs, the beds have only been rotated, not bent, because they have retained their original planar aspect.



A. Idealized concentric fold. Each layer is uniformly bent across the fold and the dip of beds increases progressively away from the fold crest.

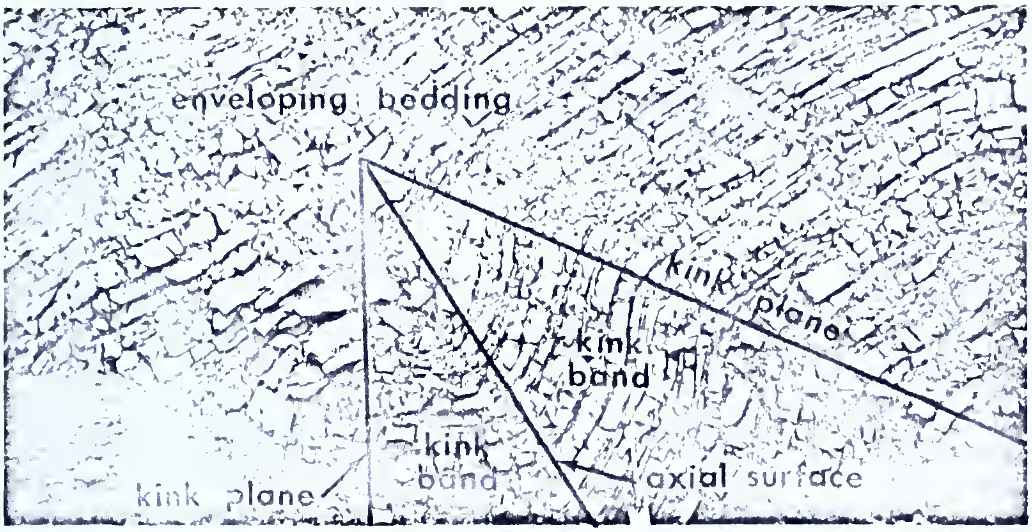
B. Typical fold in the Valley and Ridge province. Each layer is sharply bent in a narrow hinge, and the dip of beds remains constant in each fold limb. Penn-Central R. R. cut, 0.8 miles south of Mifflin, Pa.

The presence of kink bands of all sized (see previous issue of Pennsylvania Geology, v. 2, no. 5, p. 10-12) and the similar geometrical elements (narrow zones of bending, wide zones of constant bed attitude) suggest that the two structures are intimately related. For example, where two kink bands are inclined towards each other (i.e., dipping towards each other), the beds within one kink band are rotated in the opposite direction to those of the other kink band. Where these kink bands join each other, a fold geometry results (Fig. C). Each kink band constitutes one limb of the fold, and the junction between the two kink bands is the fold hinge, within which lies the axial surface of the fold. Bedding maintains a constant attitude throughout each limb because bedding in a kink band possesses a constant attitude. The bending of the beds occurs only at the junction of the two kink bands and thus the fold hinge is narrow with respect to the fold wave length. The planar aspect of bedding in the fold limbs indicates that the beds are not bent here (as they would have been in a concentric fold)—they have only been rotated to their present attitude.



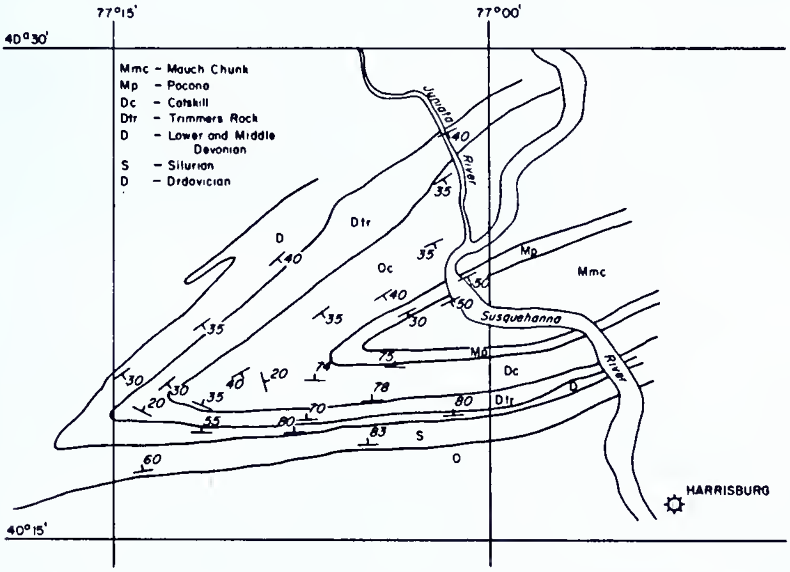
C. Generation of kink band fold by the junction of two oppositely inclined kink bands.

Thus the junction of two kink bands results in a fold which possesses the same geometrical attributes as are observed in Valley and Ridge folds, and such kink band folds can be seen in their entirety in some outcrops (Fig. D).



D. Simple kink band fold (syncline) in the Salona Formation. Route 322 road cut, at Reedsville, Pa.

Although small kink band folds can be demonstrated in outcrops, the large folds of the province are never so completely exposed. To prove that the largest folds are kink band folds, it must be shown that they possess the same geometrical elements as the smaller folds. A simple example of one of the largest folds in the province is the Cove syncline (Fig. E), which plunges gently to the east-northeast. From the representative dips plotted on this map, it can be seen that



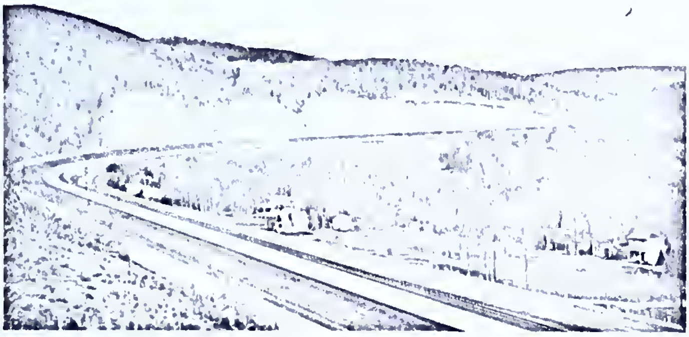
E. Generalized map of Cove syncline northwest of Harrisburg, Pa. Selected strike and dip data from J. L. Dyson's maps of the New Bloomfield quadrangle.

the dips do not progressively decrease toward the fold hinge as would be expected in a concentric fold. Rather, they remain fairly constant across each fold limb. In addition, the hinge is narrow with respect to the fold wave length—the outcrop patterns are straight in each limb, and abruptly change direction within a very short distance. These are the same geometrical attributes that are seen in small folds.

Just north of Millerstown, the hinge of the Tuscarora anticline (one of the largest folds in the province) is exposed in a road cut (Fig. F). At first glance, this fold appears to be concentric, and the radius of curvature of this hinge is approximately 0.8 miles—but the wave length of this fold is 9 miles. In concentric folds, the radius of curvature must be at least as large as, if not greater than, the half-wave length. Thus the small radius of curvature indicates that the hinge of this large fold is narrow compared to the wave length.

It can be concluded, then, that some of the largest folds in the province possess the same geometrical properties as the smaller folds. Because the small folds can be generated by kink bands, it seems probable that the largest are also kink band folds.

Rodger T. Faill



F. Hinge of Tuscarora anticline. The bending of beds within the hinge is uniform and thus approximately concentric. But the hinge is narrow relative to the wave length. Considering the entire fold, these beds are sharply bent. Routes 22-322 road cut, 0.5 miles north of Millerstown, Pa.

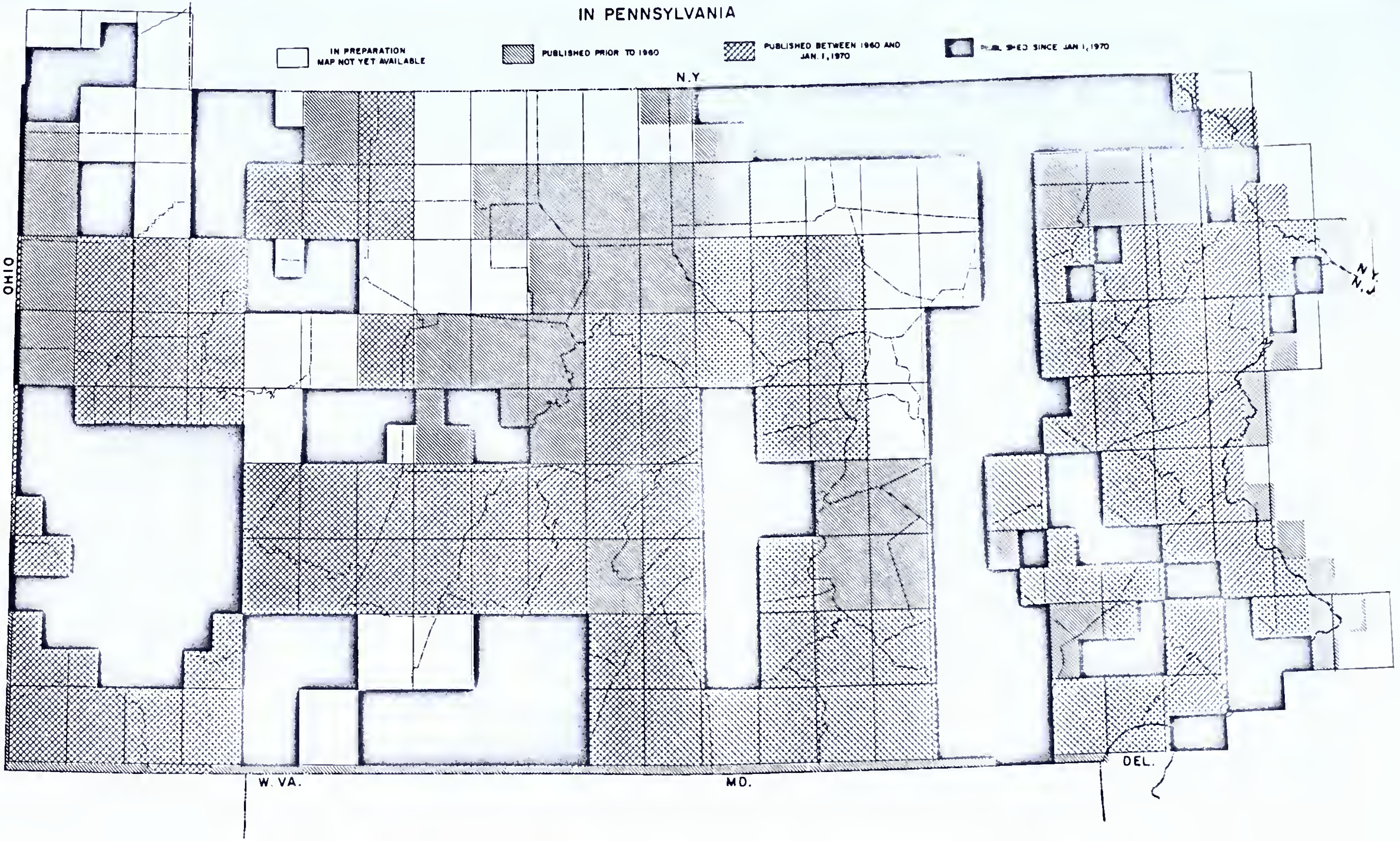
THEY KNOW US

We are often concerned that possibly some people who should be making use of our geological services may not be aware of our existence. We know now, however, that at least the Post Office knows who and what we are.

Recently at the Survey office, we received a letter which was mailed in New Jersey and was addressed simply as follows: **Somewhere in Pennsylvania Where Rocks can be obtained.** That's all there was; there was no name of a city or person. Yet the letter came directly to us without any wandering.

It's nice to know we're known.

STATUS OF 7½ MINUTE (1"=2000') TOPOGRAPHIC MAPPING IN PENNSYLVANIA


IN PREPARATION MAP NOT YET AVAILABLE
PUBLISHED PRIOR TO 1960
PUBLISHED BETWEEN 1960 AND JAN. 1, 1970
PUBLISHED SINCE JAN 1, 1970
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MD.
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TOPOGRAPHIC MAPPING IN PENNA.

The topographic mapping program in Pennsylvania is being conducted cooperatively by the Pennsylvania Geological Survey and the United States Geological Survey.

The adjoining map shows the progress to date in preparation of up-to-date 7.5 minute quadrangle (1 inch = 2,000 feet) topographic maps for Pennsylvania.

During calender 1971 an additional 143 7.5 minute quadrangle maps were published by the U. S. Geological Survey. A detailed index to these and prior published maps is available free from:

Pennsylvania Geological Survey
Dept. of Environmental Resourses
Main Capitol Annex
Harrisburg, Pa. 17120

Washington Distribution Section
U. S. Geological Survey
1200 South Eads Street
Arlington, Va. 22202

Topographic maps may be purchased for $0.50 each from the Washington Distribution Section as listed above. On such orders, customers should state the name of the map as well as the type of map desired and are urged to use order blanks supplied with the Index to Topographic Mapping in Pennsylvania mentioned above. Orders must be accompanied by cash, check, or money order in the exact amount. Stamps will not be accepted as payment.

At slightly higher costs, maps may be purchased across the counter at agents in Pennsylvania listed on the detailed index.

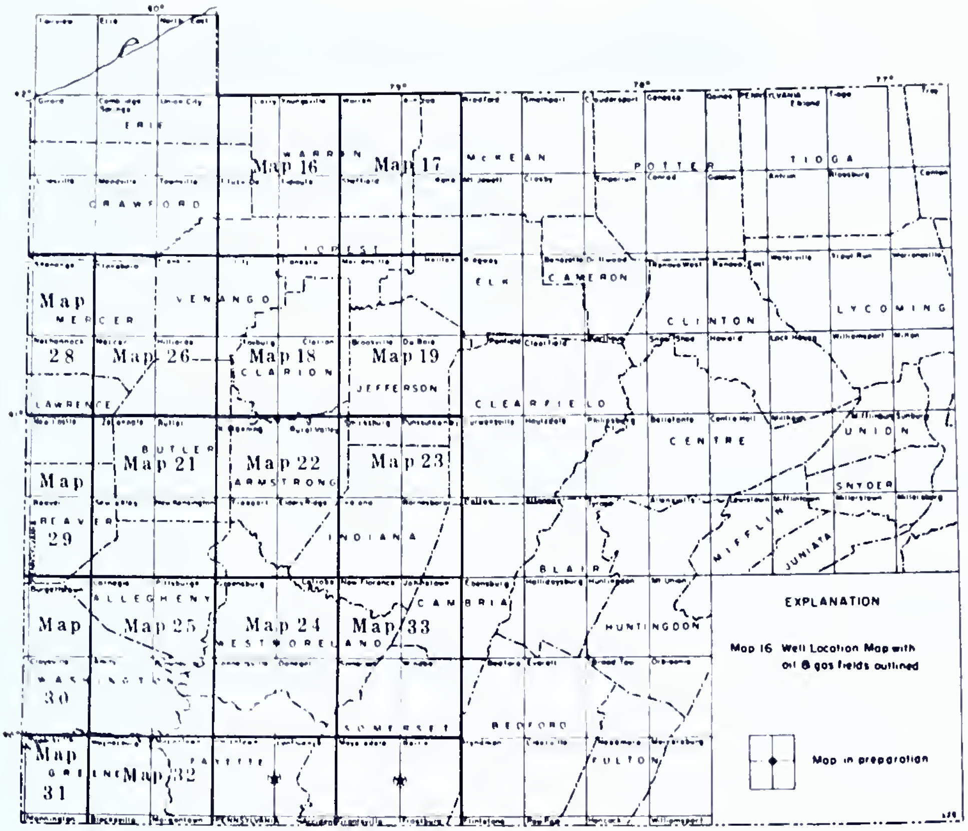
OIL AND GAS ACTIVITY IN PENNSYLVANIA

Activity in the oil and gas fields of the Commonwealth is on the increase, especially in the gas fields. Several public utility companies are giving farmouts, some covering proven gas acreage. One company is constructing a pipeline to transport the gas being developed by the farmouts. Seismic activity in the Commonwealth is at an all-time high.

The two Onondaga reef discoveries in New York have caused an active lease play in Tioga and Potter counties of north central Pennsylvania. Several major oil companies are in the play. Amoco has leased several million acres in Pennsylvania and New York. They are committed to drill a minimum of five wells in the next 15 months and eight wells in the following year.

In the newly discovered East Emporium Field of Cameron County as many as five new Oriskany development wells are contemplated. After fracturing, the discovery well had an initial production of 14 million CFGPD. The deep wildcat in Pike County in extreme northeastern Pennsylvania is drilling ahead at a depth in excess of 12,000 feet.

From January to the middle of November of 1971 a total of 562 wells had been drilled with a total footage of 978,052 feet. Of these 562 wells, 283 were oil wells, 146 gas, 25 dry, 42 service, 3 stratigraphic tests, 2 combined oil and gas, 1 disposal, 26 gas storage and 34 wells drilled deeper. The exploratory drilling for the year had discovered a small oil pool, a small shallow gas pool, and an Oriskany gas field.



NEW AND UPDATED OIL AND GAS BASE MAPS

The above index map shows the oil and gas base maps that are now available. Numbers 31, 32, and 33 are new as of January 1, 1972. Numbers 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 28, 29, 30 have been updated (posted date January 1, 1972). Paper prints of these maps, which show the locations of all the wells drilled for oil and gas since 1956 with gross field limits, can be obtained by writing to Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Cost of each map is $0.50, plus 6 percent state sales tax. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering, please specify the map number.

YORK ROCK-O-RAMA

Sponsored by the York Rock and Mineral Club, the third annual Rock-O-Rama will be held at Alert Fire Company #1, Manchester Township, Emigsville, Pennsylvania, on Saturday, April 8 (10 a.m. to 9 p.m.) and Sunday, April 9 (10 a.m. to 6 p.m.).

SULFUR REMOVAL FROM COAL GAS PROCESSES

High-sulfur bituminous coal, barred for use in most steam-electric generating plants by recent air-quality standards, is being experimentally converted into pollution-free fuel by a one-step treatment process.

A mixture of high-sulfur coal, coal tar and hydrogen is heated, pressurized and blown at high turbulence through a bed of cobalt molybdate catalyst. Products are a desulfurized fuel that can be burned like oil in powerplants; an oil for carrying more coal to the process; and hydrogen sulfide gas that can be converted into marketable sulfur.

The process is under development at Bureau of Mines Energy Research Center in Pittsburgh, Pennsylvania. In recent tests, a bituminous coal containing 3.4 percent sulfur was converted to a viscous fuel containing only 0.3 percent sulfur.

The growing demand for clean-burning fuel has also resulted in the awarding of two contracts totaling $1.2 million by the Bureau for the continuing development of a process for converting coal to gas.

from "Research and Development", September, 1971.

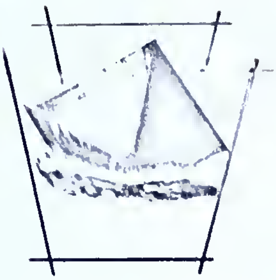
NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax. For free publications write to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

Publication		*Price*
G 60	**Pleistocene geology and unconsolidated deposits of The Delaware Valley,** by G. H. Crowl (40 p., 24 figs., 1 pl.)	$2.80
Map 27	**Industrial minerals produced in Pennsylvania** (sheet, 14½" x 21")	Free

CORRECTION

The price lists for G 56a in Vol. 2/6 of Pennsylvania Geology is incorrect, the correct price is $2.75 not $2.25.



EARTH SCIENCE TEACHERS' CORNER

Local Resident Donates Rock Collection To High School

A permanent rock and mineral collection is the latest addition to the physical science classes in Connellsville Area Senior High School. This outstanding collection was presented to the school by Ted Stillwagon, a local authority and collector whose private collection of rocks, minerals, and fossils has won acclaim throughout the United States.

Mr. Stillwagon (kneeling) points-out an unusual rock to Mrs. Mary Elizabeth Floto, the physical science instructor, and Robert P. McLuckey, principal.

The specimens are displayed in glass front cases that have been located on the second floor of the high school and adjacent to the physical science room. In addition to being a valuable asset to Mrs. Floto's classes studying earth science,

the Stillwagon Rock and Mineral Collection is open to the public during school hours: September through May - Monday through Friday from 8 a.m. to 3 p.m. and June, July, and August - Monday through Friday from 9 a.m. to 4 p.m.

The students have prepared an excellent brochure describing the Stillwagon Collection and have been in charge of elementary student field trips to the senior high and this collection. Here at the Connellsville Area Senior High School is truly a fine example of cooperation between the community, administrators, faculty, and students toward a common goal - quality education.

SURVEY ANNOUNCEMENTS

SURVEY ANALYTICAL TECHNIQUE RECEIVES WIDE APPLICATION

In 1961, the Pennsylvania Geological Survey initiated a new x-ray diffraction technique for the rapid quantitative determination of minerals in fine-grained clay mixtures. Recently, the technique has been quoted by J. Zussman in his excellent new book, "Physical Methods In Determinative Mineralogy", Academic Press, 1967. Since the original work, the Survey has continued to improve the technique. Other suggestions for improvement have been made by Professor George Brindley at Pennsylvania State University, and a refinement by Robert Davidson, Pennsylvania Department of Transportation currently is being initiated for study of raw materials used in highway construction. The Survey developed the technique for the study of raw materials used in the ceramic and lightweight aggregate industries, but it is applicable to any fine-grained rock that is not amenable to macroscopic or microscopic analysis.

NEW LIQUID DISPOSAL BOOK

The U. S. Geological Survey has published "Subsurface Waste Disposal by Means of Wells: A Selective Annotated Bibliography." With abstracts of 692 papers on technology, dispersal, and industrial case histories, this publication (U.S.G.S. Water Supply Paper 2020) is available from the Government Printing Office, Washington, D. C. 20402 for $1.50.

MEET THE STAFF

Donald M. Hoskins, Assistant State Geologist

No Bureau of State Government runs without the presence of an administrator who supervises and handles the necessary daily and mundane duties of salaries, purchasing, personnel, and budgets. The man in this job is Don Hoskins, who has been with the Survey since 1956.

In addition to handling the administrative chores for the Bureau, Don is co-authoring a Middle Devonian stratigraphic paper and is slowly completing his report on the geology of the Millersburg Quadrangle, one of the many atlas reports that the Bureau is charged to prepare. Don also serves as part-time paleontologist and assists amateurs in the identification of their fossil finds. Don wrote one of the Survey's best sellers, "Fossil Collecting in Pennsylvania", now in its second printing, which has sold over 8,000 copies.

Don received his Bachelors at Union College in 1952, a Master's at the University of Rochester in 1954. He served with the U. S. Army Corps of Engineers in Germany until 1956, and has been with the Survey ever since, except for a year and a half leave to obtain his Ph.D. degree in geology at Bryn Mawr College. While with the Survey he has been a field geologist and co-authored an atlas report on the Mifflintown Quadrangle. He then was promoted to Chief of the Field Division supervising all field mapping of the Survey. Later he was promoted to Editor, where he supervised preparation of all Bureau reports. Now Don is the Assistant Director of the Bureau and Assistant State Geologist.

With a doctorate degree in geology already accomplished, Don is currently working toward a Master's degree in State Government with the Wharton Graduate School of the University of Pennsylvania. As a hobby, he grows roses and also makes wine.

PENNSYLVANIA GEOLOGICAL SURVEY STAFF

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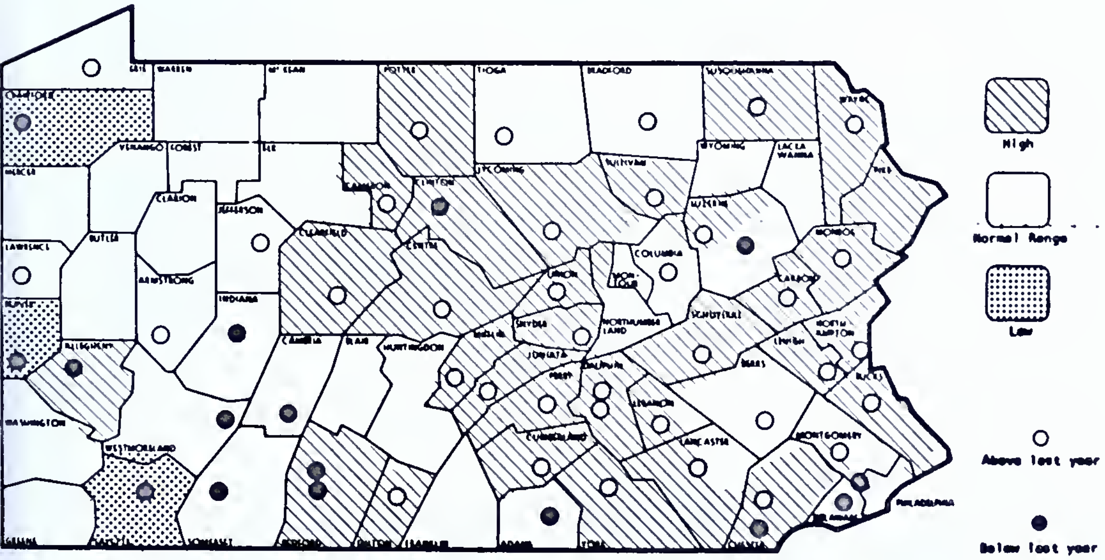
GROUND-WATER LEVELS



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PENNSYLVANIA GEOLOGY

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THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER – A good lesson in where not to build a house. Scene of flooded home in Cumberland County. Houses were built on limestone area where rapidly fluctuating water table creates havoc.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

APRIL 1972

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

GEOLOGY CAN SAVE YOU HEARTACHE

A number of problems recently brought to us have demonstrated that there is a real need to apply geologic knowledge to prevent some gross misapplications of land use.

Not far from Harrisburg is a development of neat, modest single family homes. Sadly, however, the inhabitants live in dread of each rainfall. This is a limestone terrain, honeycombed with sinkholes and solution cavities and almost completely surrounded by a belt of relatively impermeable rocks. Thus, we have here what amounts to an interior drainage basin, with rocks that take in water like a sponge. Every rainfall, therefore, results in a major rise in the water table and a few days of rain have lifted it as much as 20 feet. The result is repeatedly flooded basements. The very same town that had looked forward to this development for its tax revenue, now has a perpetual job for its fire engines - to repeatedly pump out several feet of water in the basements of the community.

The geologic setting of this area was known long before its development. Similarly, well known were the areas where near-surface impermeable diabase underlies a scenic development which has been built with on-lot sewage disposal, and a number of developments (residential as well as industrial) on classic floodplains where repeated flood conditions are a matter of known record.

The time is at hand when data on geologic problems and hazards should take priority over the desire for new taxable developments. With the proper cognizance of geologic problems, carefully integrated into land-use planning, and backed by legislative mandate that would say "Stay away from hazard areas", it would be quite possible to forestall the damage, expenses, pestilence, and heartache which still prevails today in our expanding communities.

Arthur A. Socolow

GOLD IN PENNSYLVANIA'S HILLS-AND VALLEYS

Of all the minerals, indeed of all the chemical elements, the one that has most fascinated the imagination and driven men to belief in their wildest dreams is gold. However, it would be an understatement to say that Pennsylvania has not been noted as a gold-rush state; in fact, gold is so little known in Pennsylvania that most residents probably aren't aware of its existence and its minor economic importance. One reason for this is that much of the state's gold is 'invisible' as far as seeing it with the naked eye is concerned. It has been said (not very accurately) that "gold is where you find it", but here it is a different proposition: gold is where you don't find it. Most of Pennsylvania's gold can't be found by looking for it directly. Instead, most of our gold is invisibly hidden in chalcopyrite, the copper-iron sulfide. Nevertheless, it is an economically significant by-product of iron mining. For example, more than 38,000 ounces of gold have been recovered from the magnetite iron mine at Cornwall in Lebanon County. Gold also occurs in the similar deposit at Morgantown, both operated by Bethlehem Steel Corporation.

A recent publication, "The Distribution of Gold in Igneous Rocks" by David Gottfried and others (1972) emphasizes the hidden aspect of gold in Pennsylvania diabase, and incidentally yields some other rather startling conclusions. The gold contents in the diabase rocks of Pennsylvania are listed in the accompanying table in parts per billion (ppb), a very small quantity indeed since one ppb equals .0000001%. It is clear that most igneous rocks contain less than 5 ppb and very few more than 10 ppb. Thus, the gold content of the Cornwall diabase is normal (see Table) in spite of the fact that chalcopyrite in the magnetite ore associated with the diabase contains recoverable gold. On the other hand, the amount of gold in diabase at Dillsburg is almost ten times the normal amount (see Table) and may be related to alteration processes that yielded the Dillsburg magnetite ore bodies. However, the observation that the Cornwell diabase and diabase dikes both contain a normal gold content despite the gold-bearing deposit at Cornwall leads to the implication that gold distribution in diabase and ore are not directly relatable.

A rather startling conclusion of the Gottfried (et al) study is that gold content increases with the mafic content of a rock suite; that is, that basalts and gabbros tend to contain more gold than rhyolites and granites. This trend is particularly noticeable in the calc-alkaline batholithic rock suites. To those of us who think of gold in terms of quartz "pegmatites", this is a surprising observation. To test their conclusions, individual minerals were separated and analyzed for gold. It was found that sulfides contain the highest concentrations (e.g., the chalcopyrite at Cornwall). In general, mafic silicate minerals and iron-titanium oxides are richer in gold than quartz or feldspar. Thus, the data on individual minerals support the bulk-rock analyses.

GOLD CONTENT IN IGNEOUS ROCKS, IN PPB
(from Gottfried and others, 1972)

Rock Type	Av.	Range	Range of Av.s
Oceanic basalt			0.2-4.5
Continental basalt			0.5-8.5
Calc-alkaline batholiths	3.0		
Eastern U.S. Triassic diabase			0.4-15.5
Pa. Triassic diabase dikes	3.3	1.7-7.2	
Pa. Dillsburg sheet diabase			
normal diabase	15.5	8.5-22.6	
granophyre	14.1	9.0-10.6	
Pa. Cornwall sheet diabase			
chilled margin	8.1		
normal diabase	2.1	1.8-2.8	
pegmatitic diabase	3.7	2.0-5.5	
granophyre	1.3	0.7-2.0	

None of this information refers to rich commercial deposits in vein quartz or to gold obtained from gravels where the gold is commonly visible to the naked eye. Both types of occurrences, visible and hidden, have occured in Pennsylvania, although more occurrences of the latter have been recorded and none are commercial. Below is a list by county compiled from d'Invilliers (1883), Miller (1924), Gordon (1922), Brown and Ehrenfeld (1913), and Rose (1970). It should be noted that most of these occurrences were reported over 50 years ago and cannot be verified today. Furthermore, some of the reported localities are inaccessible due to urbanization and land rehabilitation. Good luck in your hunt for this elusive, precious metal, and if you find a bonanza, let us know!

Adams - Franklin Counties: reported to occur in the copper-bearing metavolcanic rocks but exact information is lacking.

Berks County: reported with sulfides from South Mountain near Reading (d'Invilliers, 1883); also in chalcopyrite from Grace Mine, Morgantown.

Bucks County: reported at New Galena near Doylestown in galena where gold values ranged up to $0.10 per ton (in 1922); Yardley and Rock Hill associated with diabase; in chalcopyrite from Sassamansville; along Brock Creek in lower Makefield Twp. in stream gravels (reported as a news item; not verified).

Chester County: reportedly from the lead-zinc mines near Phoenixville (Wheatley, Chester County, Phoenix, and Brookdale).

Lancaster County: reported from sulfides at the Gap nickel mine.

Montgomery County: reported from the sulfides at the Ecton and Perkiomen mines; from river gravels at Hendricks Station and in Franconia Twp.; from quartz and pyrite in Douglas Twp. (Gordon, 1922); from copper sulfide deposits at Congo NE and Congo NW (Rose, 1970; Gordon, 1922); from the Yoder farm (Gordon, 1922).

Philadelphia County: reported from the Delaware River gravels and nearby bedded clays; also reportedly found in clay excavations long ago at 11th and Market Streets in Philadelphia (a thin sheet of this gold obtained from clay is reported to be at the Philadelphia Mint); from Delaware River gravels and clay at Bridesburg.

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Brown, A. P. and Ehrenfeld, F. (1913), Minerals of Pennsylvania, Pa. Geol. Survey (3rd), Rept. No. 9.

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Miller, B. L. (1924), Lead and zinc ores of Pennsylvania, Pa. Geol. Survey (4th), Bull. M-5.

Rose, A. W. (1970), Atlas of Pennsylvania's Mineral Resources, Pt. 3: Metal mines and occurrences in Pennsylvania, Pa. Geol. Survey (4th), Bull. M-50 Pt. 3.

By D. M. Lapham

NEW BIBLIOGRAPHY OF THESES AVAILABLE

Index to Theses on Pennsylvania Geology, compiled by Sandra Blust, Librarian for the Pennsylvania Geological Survey, is a compilation of theses and undergraduate papers from Pennsylvania colleges on the geology of Pennsylvania. It is hoped this publication will help the user locate sources of geologic information otherwise not available. For a copy write the Department of Environmental Resources, Bureau of Topographic and Geologic Survey. Harrisburg 17120.

INDEXES TO GEOLOGICAL MAP COVERAGE OF PENNSYLVANIA

The Pennsylvania Geological Survey is responsible for providing detailed geological maps of Pennsylvania. Much of the continuing work of the Survey is aimed at providing new maps in areas where there are none, as well as to up-date previously mapped areas where there is a need either because of increase in population, or because of growth in one of more of the natural resource industries.

We have compiled the accompanying maps on the following two pages showing areas covered in the two primary scales of maps: 1:62,500 and 1:24,000. These maps are all from publications listed in "Pennsylvania Geological Publications", a list provided free by writing to the:

Pennsylvania Geological Survey
Department of Environmental Resources
Harrisburg, Pennsylvania 17120

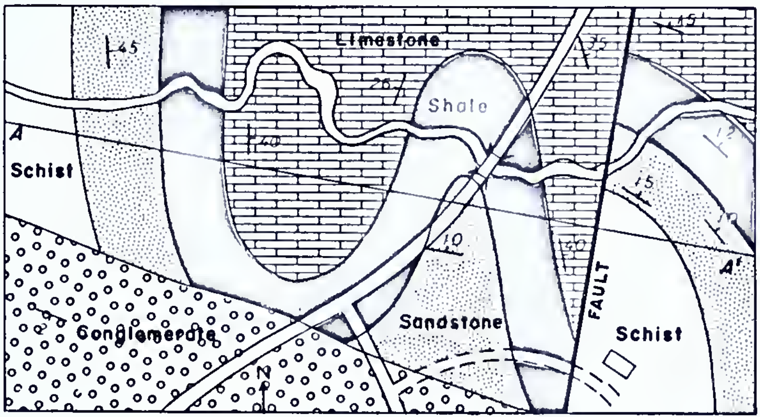
The list provides an index by counties and index maps indicating the publication number centered on areas covered by the various reports.

Geological map coverage of Pennsylvania is also shown, together with a bibliography, in the U.S. Geological Survey publication "Geologic map index of Pennsylvania" by Leona Boardman, 1952, available for $0.60 from:

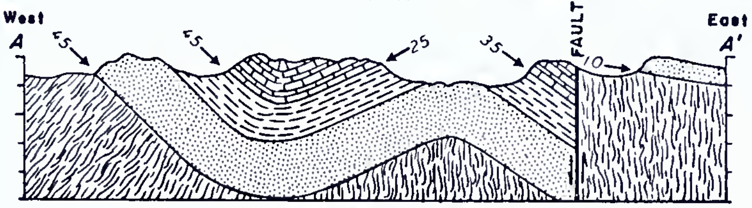
U.S. Geological Survey
1200 S. Eads Street
Arlington, Virginia 22202

The 1952 USGS index, has recently been republished and will be kept in print.

An additional index similar to the one compiled by Boardman is in press at the U.S. Geological Survey. The new U.S.G.S. index covers maps published from 1952 to 1971 and will be available shortly.



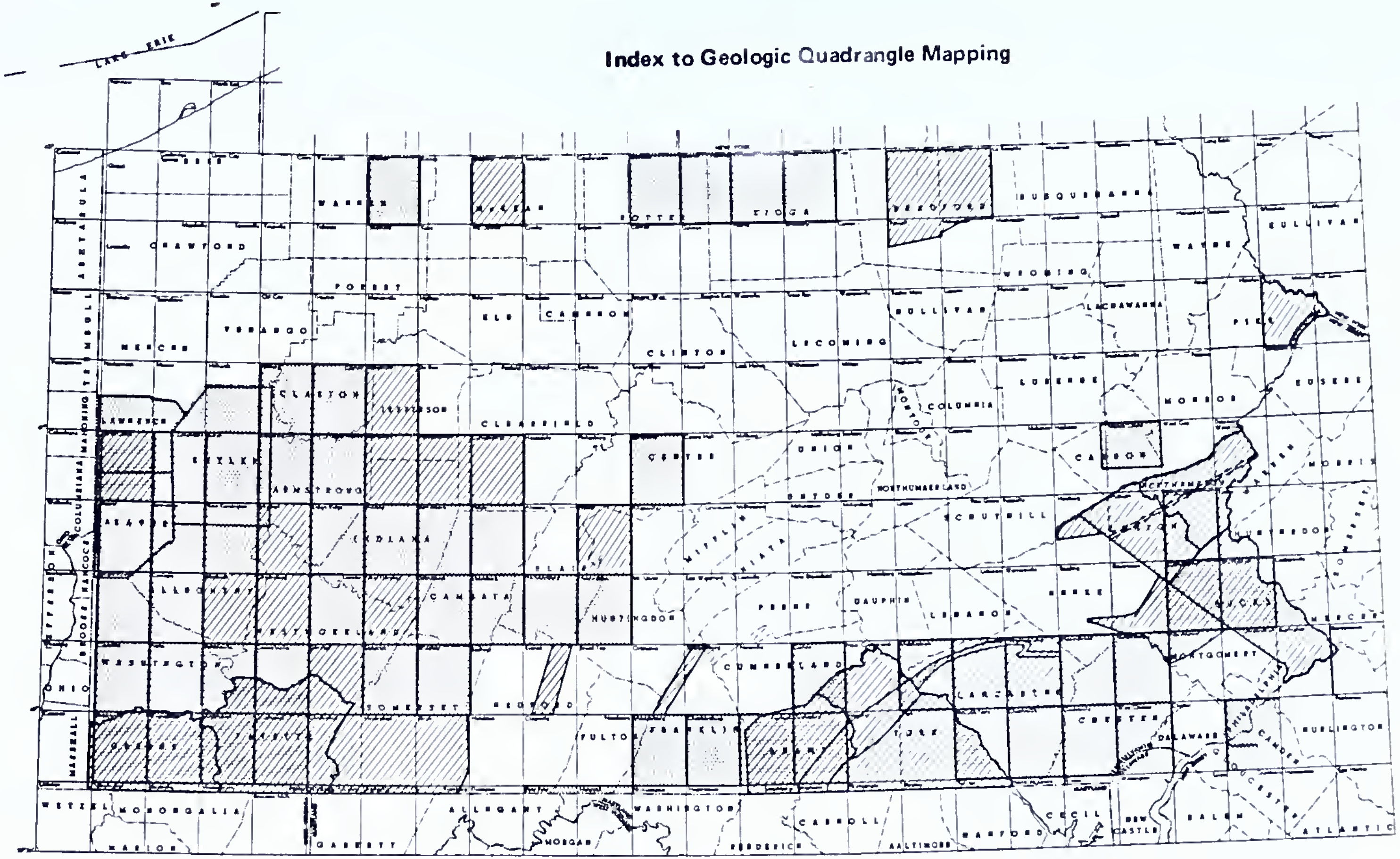
MAP



Cross sections *A–A'*

(continued)

Index to Geologic Quadrangle Mapping

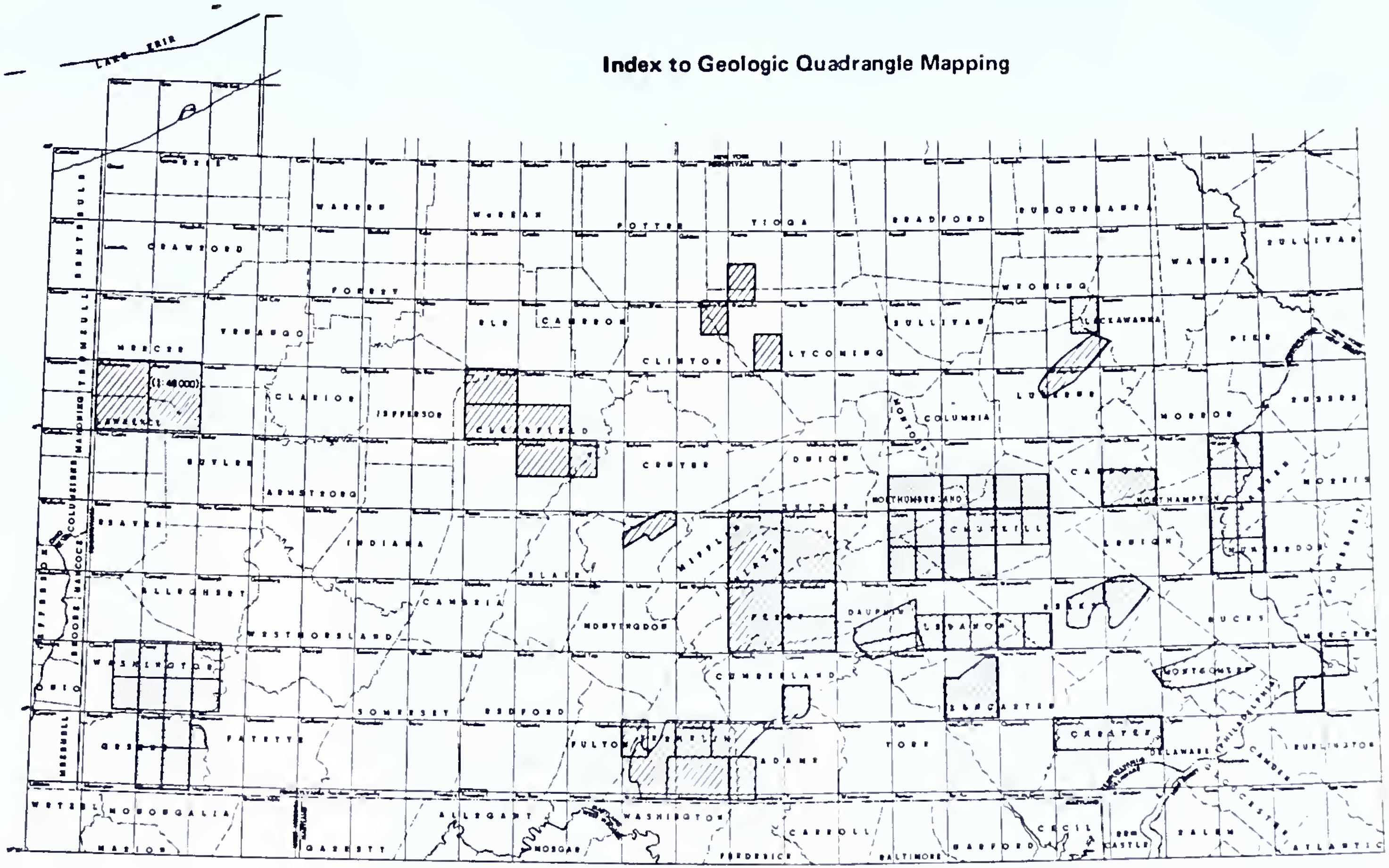


Quadrangle Geologic Mapping (Scale 1:62 500)

▢ United States Geological Survey

▨ Pennsylvania Geological Survey

Index to Geologic Quadrangle Mapping



Quadrangle Geologic Mapping (Scale 1:24000)

☐ United States Geological Survey

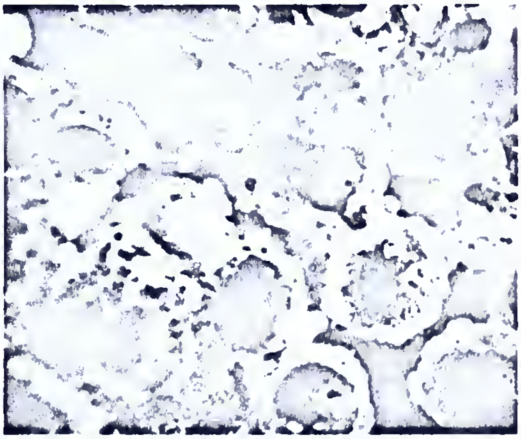
▨ Pennsylvania Geological Survey

SELENIUM: PENNSYLVANIA'S RAREST MINERAL?

Native selenium is one of the newest and probably most unusual additions to the long list of minerals found in Pennsylvania. This mineral was discovered in July 1971 by Mr. Wayne Downey of Harrisburg in Luzerne and Dauphin counties. The identification of the mineral was made by the Pennsylvania Geological Survey.

The mineral apparently occurs in several forms: as black, metallic, hexagonal crystals, many of which are in the form of hollow tubes, as small metallic hairs, and as gray, metallic balls of amorphous selenium mixed with sulfur. The metallic balls are enclosed by crystals of cryptohalite, a mineral previously found by Mr. Downey in Schuylkill County (Barnes and Lapham, 1971). The selenium is forming by sublimation under the artifically induced fumarolic conditions of burning coal beds and culm banks. The selenium was concentrated by the plant material that eventually became today's anthracite coal. It has never before been reported to occur in Pennsylvania and Palache et al (1951) list only two other occurrences in the world, in Arizona and Czechoslovakia, both at burning coal mines.

Selenium Crystals



Balls of Amorphous Selenium Surrounded by Cryptonalite.

Selenium has unusual electrical properties which make it very useful in the manufacture of photoelectric cells and other solid state electronic devices. It also is used in Xerography, in the manufacture of stainless steel, as a photographic toner, and in the glass industry to decolorize glass and to make red glass. However, the quantity found in Pennsylvania is not of economic significance unless it could be refined as a by-product from the use of coal waste.

Two other rare minerals have been found associated with the selenium in Luzerne County. One, ammonia alum, occurs as small, colorless crystals that form slowly from the evaporation of a clear liquid. The other, realgar (arsenic sulfide), forms brillant red monoclinic crystals. The occurrence of realgar has not been noted previously in Pennsylvania. A material tentatively identified as ammonia alum previously has been reported from a mine near St. Clair in Schuylkill County (Montgomery, 1969, p. 28).

Coal mine fires are a waste of a valuable resource, a pollution hazard and an irritant to all who live near them, but this cloud has a selenium lining: we are learning much about potentially valuable trace elements in coal.

John H. Barnes
Davis M. Lapham

REFERENCES

Barnes, J., and Lapham, D. (1971), **Rare Minerals Found in Pennsylvania**, Pennsylvania Geology, v. 2, n. 5, p. 6-8.

Montgomery, A. (1969), **The Mineralogy of Pennsylvania**, Academy of Natural Sciences of Philadelphia, Special Publication No. 9, p. 28.

Palache, C., Berman, H., and Frondel, C. (1951), **Dana's System of Mineralogy, Volume II,** John Wiley and Sons, Inc., New York, 1124 p.

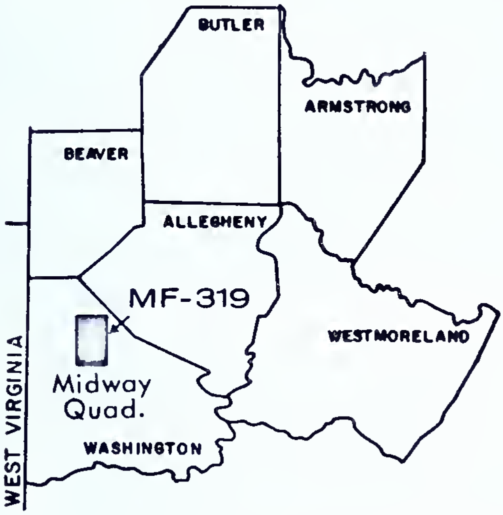
SURVEY ANNOUNCEMENTS

THE PENNSYLVANIA SURVEY MOVES

On April 17, 1972, the Pennsylvania Geological Survey moved to new headquarters at 100 North Cameron Street in Harrisburg. Mail to the Survey should continue to be addressed to the Department of Environmental Resources, Bureau of Topographic and Geologic Survey, Harrisburg, Pennsylvania 17120. A future issue of "Pennsylvania Geology" will contain a map and directions on how to get to our new quarters.

THE GREATER PITTSBURGH REGIONAL STUDIES PROGRAM

The first map, "Preliminary Geologic Map of the Midway Quadrangle, Washington County" has been released by the Greater Pittsburgh Regional Studies under the U. S. Geological Survey's rapid-publication procedure. This map was prepared by John B. Roen in cooperation with the Pennsylvania Geological Survey. The Survey's rapid-publication procedure stems from the need to get resource maps and other geologic information into the hands of potential users as quickly as possible so that the information may be incorporated in better-based plans for the improvement and development of the region. This black and white map represents release of valuable data perhaps more than a year in advance of the multi-color version.



Outcrop lines of principal coal seams are shown, as are areas within the 56.7-square-mile quadrangle where coal has been mined-out by surface (strip) and underground mining. Distribution of economically significant sandstone, limestone, clay, and shale also are indicated, and the search for additional oil and gas supplies may be assisted by structure contours drawn on the map. Areas of unstable slopes are evidenced by the presence of landslide deposits.

Ensuing releases by the Greater Pittsburgh Regional Studies will include those with geologic data, hydrologic data and environmental interpretations of the six-county region, as well as those concerning parts of the region.

A copy of the Midway geologic map (Miscellaneous Field Studies Map MF-319) may be obtained free of charge from: Greater Pittsburgh Regional Studies, U. S. Geological Survey, P. O. Box 420, Carnegie, Pennsylvania 15106.

HOW MANY MINERALS ARE THERE?

Dr. Michael Fleischer, U. S. Geological Survey, has just published a complete "Glossary of Mineral Species: 1971". The total number of mineral species and varieties comes to 2218, excluding names of mineral groups and synonymous names. The publication is available from the Mineralogical Record, Inc., P.O. Box 783, Bowie, Maryland 20715.

SUSQUEHANNA SEDIMENT

Under existing land-use and average-runoff conditions, the Susquehanna River transports about 3.0 million tons of sediment annually (110 tons per sq mi). However, only about 1.8 million tons of sediment enters the head of the Chesapeake Bay, because some sediment is trapped behind the power dams of the lower Susquehanna. Measured sediment yields range from 40 tons per sq mi to 440 tons per sq mi. The lowest sediment yields in the basin are from the Susquehanna main stem in the glaciated part of the Appalachian low plateau, the Valley and Ridge, and parts of the heavily forested Appalachian high plateaus. The highest yields are from parts of the Chemung River basin in the glaciated section of the Appalachian low plateau, the anthracite coal region, and the Piedmont. If sediment could significantly affect a water-resources project in the Appalachian low plateau, in the anthracite coal region, or in the Piedmont, thorough sediment studies should be undertaken.

Geology in the Valley and Ridge appears to be a variable that affects sediment yields, because basins containing more than 25 percent limestone have significantly lower sediment yields than basins having identical land use but containing less or no limestone. No relations were developed for the relatively small area of the Piedmont within the Susquehanna because sufficient sites were not available.

The Piedmont streams, as well as the main stems of Conodoguinet and Yellow Breeches Creeks, have significant suspended-sediment concentrations most of the time. Generally, other streams in the Susquehanna basin have such concentrations only during, and for a few days after, storm-runoff events.

The average particle-size composition of sediments transported by streams in each physiographic province is fairly consistent, being about 10 percent sand, 50 percent silt, and 40 percent clay.

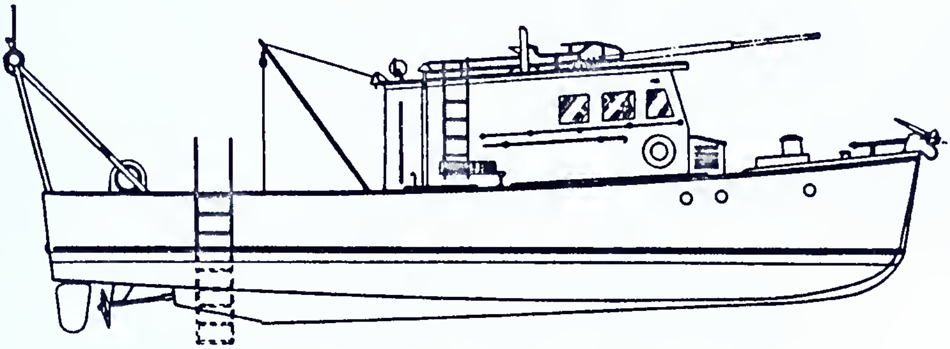
Generally, reservoir sedimentation is a minor problem for all reservoirs. A few severe problems occur in reservoirs having low capacity-inflow ratios, in reservoirs constructed in areas having high sediment yields, and in reservoirs subjected to temporarily excessive sedimentation from urban and highway construction.

Continuous sediment records for Juniata River at Newport, Pa., indicate that there has been a 25-percent reduction in the sediment discharge from the Juniata River basin between 1951 and 1967. Considerable evidence exists to show that, owing to the decline of anthracite coal mining and processing, there has also been a downward trend of sediment discharge for the main stem of the Susquehanna River. In the future, the high sediment yields associated with urbanization may offset this present downward trend in sediment discharge.

from U.S.G.S. Water Supply Paper 1532-F

NAUTICAL! NAUTICAL!

The Splash Zone, newsletter of the Marine Science Consortium, carries the announcement of the acquisition from the U.S. Navy of a 50-foot mine diving tender. This boat when renovated will enable students and researchers associated with the Consortium to conduct studies on the Atlantic continental shelf. Further information on the program may be obtained from Marine Science Consortium, Inc., P. O. Box 43, Millersville, Pennsylvania 17551. The following academic institutions are members of the Consortium: Bloomsburg State, California State, Catholic University (D.C.), Cheyney State, East Stroudsburg State, Edinboro State, Indiana Univ., Kutztown State, Millersville State, Pennsylvania State, Shippensburg State, Slippery Rock State, and West Chester State.



"BOTTLING THE ENVIRONMENT"

The nation's glass capital now has the longest glass-paved road in the world, and the first to include waste glass in sub-surface layers. The glittering "Glasphalt" pavement was implaced on a 1,000-foot strip of North Westwood Street, Toledo, Ohio.

"Glasphalt" is a combination of crushed waste glass, sand, limestone crushed rock, and asphalt which is undergoing extensive tests to determine its suitability for road surfaces as one means of reusing discarded bottles and jars, thus conserving natural resources and helping reduce the solid waste disposal problems.

Mr. C. R. Hanes, director of research and development for the Ohio Department of Highways, said that the department anticipates the surface layer containing glass aggregate will promote highway safety by providing a good level of skid resistance.

The first test strip of "Glasphalt" in the world was installed October, 1969, by Owens-Illinois at a parking lot entrance at the company's Toledo Technical Center. Since Toledo's first installation, "Glasphalt" paving has been installed in many cities, including Brockway, Pa.

(Source: APC HIGHWAY BUILDER)

EARTH SCIENCE TEACHERS' CORNER

survey of secondary school earth science

The number of public school students taking earth science each year in Pennsylvania now exceeds 130,000. This is the largest secondary earth science population in any state. Earth science teachers in Pennsylvania number in excess of 1000. Many changes in teacher training and types of programs offered in the classroom have taken place in recent years. In order to determine the current status of these teachers and programs, the following organizations are sponsoring a survey to be conducted by Temple University between January and May of this year:

1. The National Association of Geology Teachers (NAGT)
2. The Earth Science Curriculum Project (ESCP)
3. The Earth Science Teacher Preparation Project (ESTPP)

The survey will be conducted in two parts. The first part will involve a general questionnaire being sent to a sampling of earth science teachers across Pennsylvania; the second part will include a questionnaire being sent to ESCP teachers through their science department chairmen—in schools reportedly offering ESCP. (It is estimated that approximately 35% of the students studying earth science in public secondary schools are using the ESCP text: INVESTIGATING THE EARTH.) The chairmen are requested to forward the questionnaire to the ESCP teacher. Copies will be made available for additional teachers. It is hoped that all ESCP teachers will notify their science chairmen to forward the questionnaire as soon as it arrives.

Information being sought by both questionnaires includes:
-the background of the earth science teacher
-teaching loads; facilities and materials available
-text(s) being used
-techiniques of grading and conducting classes
-degree of student participation
-problems in teaching ESCP.

All of the information will be available to you through PENNSYLVANIA GEOLOGY and JOURNAL OF GEOLOGICAL EDUCATION. In these questionnaires; no courses or programs are being "pushed"; teachers are *not* being

graded; *no* single way of teaching is being proposed. All data will be coded and processed by computer at Temple University in such a manner as to prevent identification of individual teachers and schools.

If you receive one of these questionnaires, please take the time to complete it and return it.

ESCP – CURRENT STATUS

In 1971, the Earth Science Curriculum Project was officially terminated. In its place, the American Geological Institute has organized the Earth Science Educational Program which has received funding for two major new projects:

1. Environmental Studies (ES) - "a combined curriculum and teacher-preparation program aimed at urban students. Staff members and participating teachers are creating ways of helping to stimulate urban children to study their environment. Ambiguous assignments, such as "Go out and photograph evidence of change" and "Go out and make a photographic map of the neighborhood", invite widely divergent kinds of student activities. The interdisciplinary implications of this approach are clear, and we can expect biologic and ecologic aspects of the environment. Prelininary materials for ES were developed under the ESCP Laboratory Blocks program. The new Project is in full swing at the present time, with testing and development activities proceeding in 11 test centers in U. S. cities" (Romey, William D., 1970, ESCP: A project in Transition: *The American Biology Teacher,* v. 32, n. 6, pp. 343-347.
2. Earth Science Teacher Preparation Project (ESTPP) - "The goal . . . is to make a comprehensive attack on the rigid qualities characteristic of teacher preparation programs-qualities that are carried into secondary and elementary school classrooms by newly certified teachers. One of the primary targets is the college program for pre-service teacher education. ESTPP also plans extensive efforts in the direction of encouraging and stimulating suitable changes in in-service, summer, and academic-year programs for teachers and school administrators" (Romey, 1970).

The current philosophy with which the Earth Science Educational Program is functioning is summed up by William D. Romey, Director of ESCP and ESEP:

> "The ESCP staff and many of the successful teachers we have identified feel strongly for the need for improved teacher preparation along new lines. Having made the transition from didacticism to a managerial approach, we are seeking ways of stimulating a truly intrinsic motivation in students. From our observations and experience one thing is clear: we cannot expect students to find our materials intrinsically interesting if teachers impose a rigid structure in their classrooms. This indicates the following:

1. Teachers must be trained to take our program apart, rather than go through it chapter by chapter. The rigid schedules we orginally proposed are neither realistic nor pedagogically sound, in that they stress maximum coverage of externally imposed subjects rather than the intellectual growth of students.
2. Teachers must be willing to drop many parts of the program altogether. Different teachers should drop different parts for different students.
3. Teachers must be trained to allow individual students to make significant decisions about what is to be studied.
4. We must encourage teachers to be less concerned about maintaining artificial constraints and more concerned about their students as human beings.

In short, the ESCP staff would like to see INVESTIGATING THE EARTH considered henceforth as a resource for an earth science course, rather than as a unique program around which to structure a whole course."

Both projects have the same address as ESCP: P. O. Box 1559 Boulder, Colorado, 80302. A quarterly newsletter is available.

Whitman Cross II
William Penn Charter School

GEOLOGISTS MUST BE ACTIVISTS

In a speech before the Oklahoma City Geological Society, Gene P. Morrell, Director, U.S. Office of Oil and Gas, Department of the Interior, urged geologists to take their "knowledge to the American people and to translate . . technical language into words the layman can understand."

"In the final analysis, the public will determine energy policy, either through their actions in the marketplace or at the polls. Whether well-informed or misinformed, they will make their decisions. It is our responsibility to assure that decisions are based on solid, accurate data."

Some highlights from Mr. Morrell's speech include:

- - - "The critical period in energy supply in this country will be the next 10 or 15 years."

- - - "Unfortunately, Congress has not completed action as requested on President Nixon's legislative proposals for clean energy for the future" nor on the President's proposal for a Department of Natural Resources. Both of these actions are needed to alleviate the energy crisis.

- - - "Today we, who comprise only 6 percent of the global population, consume about one-third of the world's energy output . . ."

- - - "The translation of today's average American's fuel needs in gallons, pounds, and pints finds that everyday, each American's uses 3 gallons of oil, 2 -1/3 gallons of natural gas, 14 pounds of coal, 2 jiggers of nuclear energy, and one quart of hydropower."

MEET THE STAFF

WILLIAM D. SEVON, FIELD GEOLOGIST

William D. Sevon is in the Field Geology Division of the Pennsylvania Geological Survey. Since joining the Survey in 1965, he has been doing geologic mapping in Carbon and Monroe counties where he has been able to make good use of his special interests in glacial and periglacial geology. The current program anticipates completion of geologic mapping in Monroe County in 1972 and the start of mapping in Pike County in 1973. The projects result in geologic maps of the rocks and the unconsolidated surficial deposits of the area, descriptions of each mapped unit and economic and environmental interpretations of each unit.

Bill was born and raised in Andover, Ohio, and obtained a B.A. degree from Ohio Wesleyan University in 1955. He obtained an M.A. degree from the State University of South Dakota in 1958 and a PhD from the University of Illinois in 1961. Bill has a variety of professional experience which includes a summer of mineral exploration with Horsethief Canyon Uranium Co., Inc., four summers of geologic mapping with the South Dakota Geological Survey and four years as a lecturer in Geology at the University of Canterbury, Christchurch, New Zealand. He is a member of numerous professional societies and is currently president of the Harrisburg Area Geological Society. Bill has written over 20 published papers and abstracts and the Survey currently has two of his reports in press.

Bill, his wife Joan, and their two sons, Douglass and David, recently returned from a combined vacation-research trip in New Zealand. Bill worked on the sedimentology of some Tertiary rocks in the Province of Canterbury and also examined the sedimentary structures of beach and dune sands on Farewell Spit.

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In Cooperation with The U.S. Geological Survey

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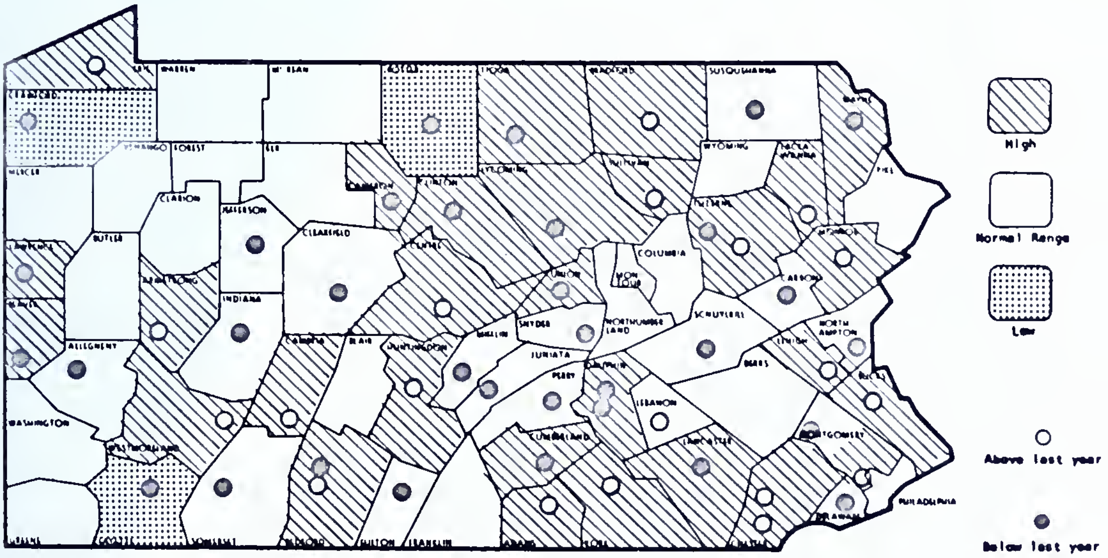
MARCH 1972
GROUND-WATER LEVELS



PENNSYLVANIA GEOLOGY

DISASTER

We regret to announce that the new quarters of the Pennsylvania Geological Survey were totally destroyed by the Harrisburg flood on June 23. Our proud library of 40,000 volumes, our collections, and our laboratories are gone. Our collection of over 200,000 topographic and geologic maps is gone, and our voluminous photo files were all totally destroyed. Obviously, this is a major disaster to us and to all whom we serve.

Continued on Page 1

THE PENNSYLVANIA GEOLOGICAL SURVEY
VOL. 3/3

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

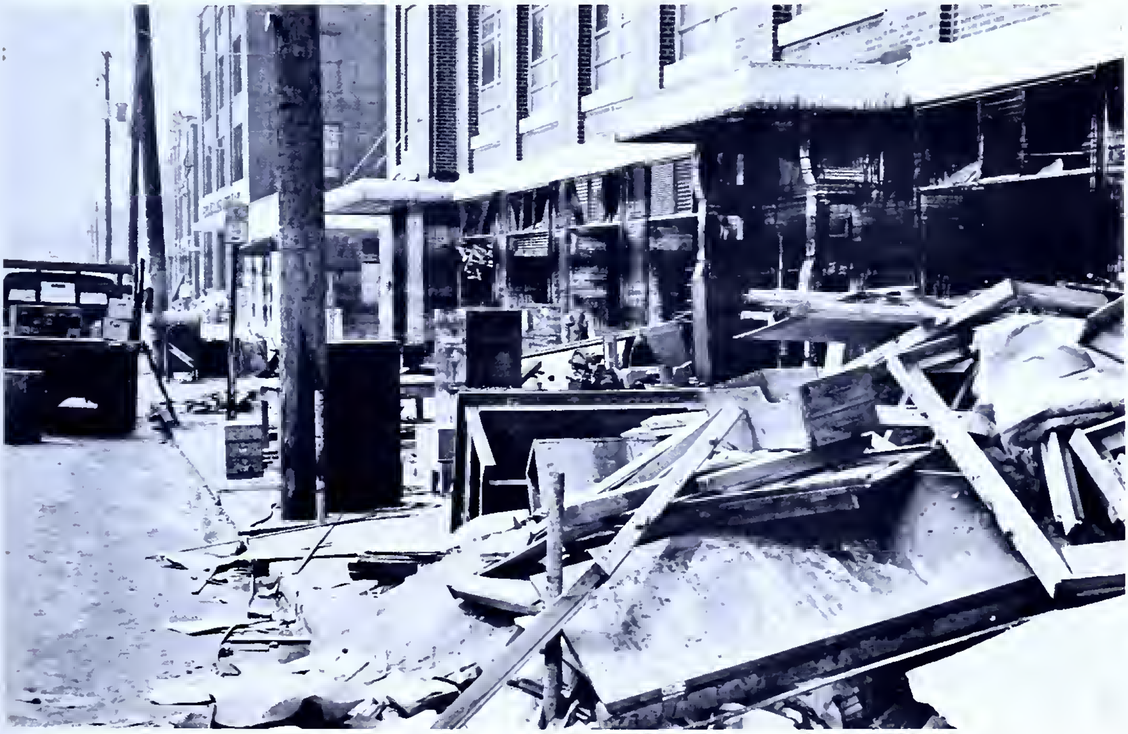
JUNE 1972

FROM THE DESK OF THE STATE GEOLOGIST . . .

At present we are in temporary quarters trying to salvage some few oil soaked, water-logged manuscripts and office records. Our mail address remains the same, as does our phone number.

We shall rise again from the ruins. Undoubtedly we shall have to call upon many of our friends for assistance to replace portions of our library which are out of print. Most of all we beg your patience until we can again be in a position to render the many services we have offered in the past.

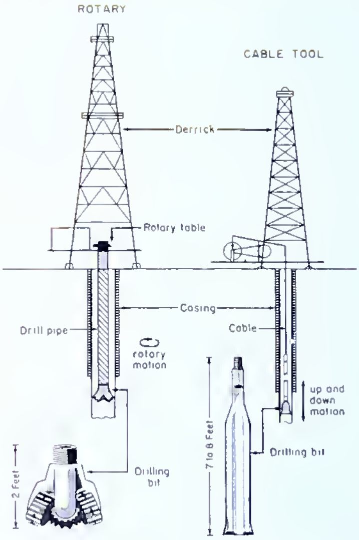
Arthur A. Socolow



Flood destruction of The Geological Survey Offices

PENNSYLVANIA'S BOOMING OIL AND GAS SEARCH

The scarcity of fuels, particularly oil and gas, to meet our energy requirements, the discovery of gas in the Onondaga reef just north of the Pennsylvania - New York line, and a new awareness of the tremendous thickness of the unexplored sedimentary column (30,000 feet) has caused more leasing and drilling activity than has been seen in Pennsylvania since the discovery of the Leidy Field in Clinton County.



Millions of acres have been leased in recent months throughout the oil and gas belt in an area from Greene to Bedford Counties on the south, then north to a line connecting Erie and Tioga Counties and then east to Wayne and Pike counties. The acreage acquired, in many instances, must first be evaluated before drilling can be started.

Nevertheless, several companies have scheduled deep tests to be started during the current year. Columbia Gas Transmission is drilling a well in Wayne County to the Queenston of Upper Ordovician age to a total depth of 13,000 feet. This well is presently drilling at a depth of over 10,000 feet. Troy Enterprises has scheduled a 11,000 foot basement test in northwestern Pennsylvania to be started before the years end. Pennzoil and AMOCO are together on a basement test which is located along the New York - Pennsylvania line, possibly on the New York side. AMOCO hopes to get a couple more deep tests started this year. United Natural Gas Company wants to drill two Silurian tests. Trend Exploration has made a location for an Oriskany test in Cameron County. This is the first of six wells they hope to drill this year to test for gas in Onondaga reefs or the Oriskany sandstone. AMOCO, Gulf and Humble are interested in northeastern Pennsylvania as well as in other areas in the Commonwealth. Shallow drilling commitments in leasing agreements made by some companies have been farmed out to other companies who will complete the wells in 1972.

And so it goes, but it is not all for gas. The refiners all need oil to keep their refineries going. Quaker State's new Congo refinery needs 10,000 barrels per day of crude oil to run at capacity. This refinery just went on stream in May, 1972. So things are wide open, and whether crude oil or natural gas is found, it can all be used. Primary production yields only 25 percent of the oil in the reservoir. Therefore, man continually tries to recover at least some of the remaining oil. That is why you hear such words as "Maraflood"—(A method developed by Marathon Oil Company to produce a lot of the oil left in the ground); three Maraflood projects are currently in operation in the Commonwealth; "Nergas"—(a repressuring process using exhaust gas from a diesel engine as a driving medium), six projects now in operation in Pennsylvania; and "Waterflooding"—(water used under pressure to drive the crude oil to the producing well bore) systematic intensive "floods" started in Pennsylvania in 1928 and are still continuing.

One refiner has started an incentive program to encourage the oil operator to drill for oil. Quaker State Oil Refining Company has offered operators in southwestern Pennsylvania 50 cents more a barrel for all new crude oil produced during the first 12 months of production with the crude being available to the refinery for at least the first three years. The wells must be drilled between April 1, 1972 and March 31, 1973.

Although 1971 was a big year for leasing and seismic activity in Pennsylvania (crew weeks totaled 147 in 30 counties) it has continued at the same rate during the first five months of 1972. Out of all this activity, there will be some discoveries made. If a discovery is a major one, then Pennsylvania will see activity that it hasn't seen for some time.

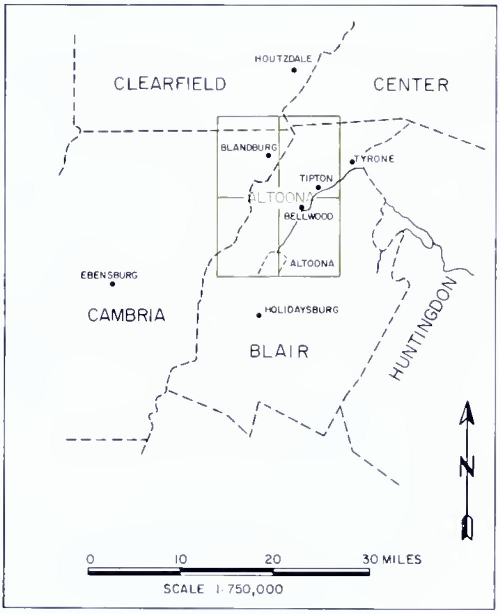
William S. Lytle

ALTOONA AREA GEOLOGIC STUDY INITIATED

The Pennsylvania Topographic and Geologic Survey is initiating a comprehensive geologic investigation of the Altoona area starting in June, 1972. This project will include the compilation of detailed geologic, mineral resource and environmental factor maps which should help to stimulate future development projects beneficial to the area.

Altoona and surrounding communities comprise a growing metropolitan area and information resulting from the new geological study will be of particular interest to the urban and rural planners, construction engineers, mineral industries, professional geologists, and conservationists. Special attention will be focused throughout the investigation on those aspects of the geology that control and affect the environment, thus assisting sound, orderly planning and development.

Pennsylvania Survey geologists Albert D. Glover and John H. Way, Jr., the principal investigators, will be working in the Altoona area for the next several summers. The Altoona geological project is scheduled to continue into 1975. This project is just one of the many urban area geologic studies being carried out by the Pennsylvania Geologic Survey. By providing accurate maps and detailed reports of its geological investigations, basic technical data is made available in a format understandable to all who require geologically oriented information.



SIMPLIFIED METHOD FOR CALCULATION OF MINERAL RESERVES OR "THE PENNSYLVANIA PLANIMETER ELIMINATOR"

A new way of computing tonnages of coal reserves from geologic maps has been developed by geologists in the Field Geology Division. The estimation of coal reserves has always been considered a necessary—although time consuming—part of compiling geologic reports in the Allegheny plateau. In recent years, the principal means used by the Pennsylvania Geological Survey for determing areas underlain by coal beds on geologic maps has been the rolling planimeter. The new technique makes use of a point-counting method similar to that used in petrographic modal analysis of rock thin-sections.

The proportion of a surface, such as a geologic map or a rock slab, underlain by any given constituent, such as a coal bed or mineral type, can be determined by overlaying an array of equally-spaced points on the surface, counting the number of these points which are located in the area of interest, and then dividing this number by the total number of points used. Theoretically, this method will be 100 percent accurate when an infinite number of points are used. In practice, it is found that a reasonably accurate estimate can be made using 1600 points.

Once the proportion of the map underlain by the coal bed, excluding mined-out areas, is known, the tonnage of coal is calculated by multiplying this figure by the total number of acres in the map area, and then multiplying by the average thickness of the coal bed. This gives the total number of acre-feet of coal present, which when multiplied by 1800, (the average number of tons of bituminous coal per acre foot), gives the total tonnage in that particular bed in the map area. For anthracite coal, a figure of 2,200 tons per acre foot is used.

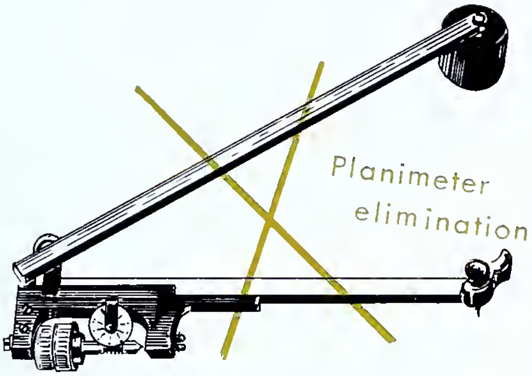
The total number of acres in a map area can be found by using the equation

$$A = \frac{L \times W \times S^2}{(144)\ (43{,}560)}$$

where A is the total map area, in acres, L and W are the length and width of the map, in inches, and S is the map scale. This equation can be simplified by the substitution of constants which depend on the scale of the map. A few examples for the determination of map areas, in acres, for some commonly used map scales are given in Table 1.

Table 1. Determination of total map area, in acres, at various map scales.

1:24,000	$A = L \times W\ (91.83)$
1:48,000	$A = L \times W\ (367.3)$
1:62,500	$A = L \times W\ (622.7)$
100 feet/inch	$A = L \times W/4.356$
400 feet/inch	$A = L \times w\ (3.673)$
1,000/inch	$A = L \times W\ (22.96)$



To test the accuracy of this method, it was used to calculate the tonnage of coal reserves in the Lower Kittanning coal bed in the northern half of Penfield 15-minute Quadrangle, which has been mapped by Thomas M. Berg and Albert D. Glover, to be published as Geologic Atlas Report A-74 ab. To obtain the proportion of the map underlain by this coal bed, each edge of the map was first marked off in 40 equally-spaced divisions. Lines drawn across the map connecting these points would produce a grid of 1600 equally-spaced points. However, the drawing of lines on the map can be avoided by the use of a straight-line template. A straight-edge was laid along the left edge of the map, and the division marks were transferred to it. The next step is to move this straight-edge across the map, one division at a time, and record the number of points falling on the map pattern of the area underlain by the coal, for each traverse. These are then totalled up and divided by 1600 to get the percentage of the map area underlain by the coal bed.

Using this method, a figure of 56.4 percent or 40.291 acres was obtained in 90 minutes of point-counting. The area of this coal bed had previously been determined by the use of a rolling plaimeter to be 39,776 acres, or 55.6 percent of the map area. However, the area calculation by planimeter involved over 50 man-hours of work. Total tonnage of Lower Kittanning coal still in the ground in the northern half of Penfield Quadrangle is 178,992,000 tons (using the planimeter method) or 181,472,000 tons (using the point-counting method). The difference in the resulting estimate is approximately one percent, and the speed of the point-counting method represents a saving in calculation time of more than 95 percent.

The point-counting method for determining areas can also be applied to the evaluation of other mineral deposits such as limestone or clay, and can be used to find the volume of fluid reservoirs in porous rock formations.

Richard B. Wells
Field Geology Division

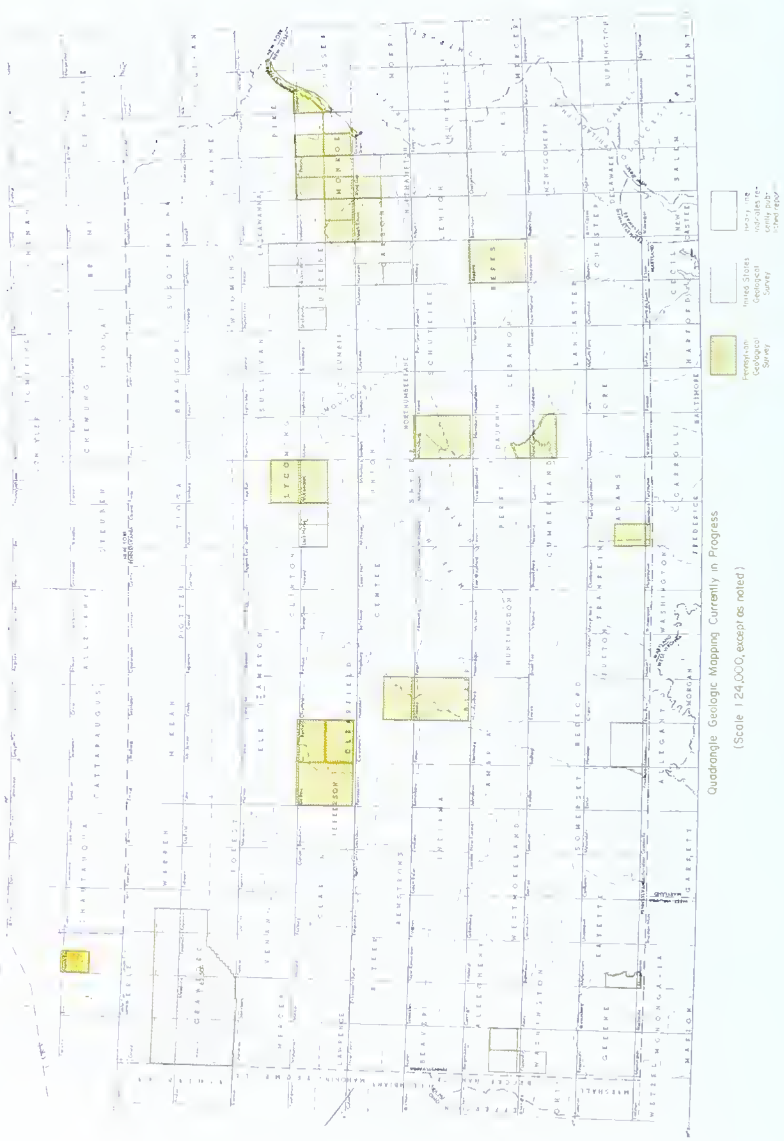
WORLD'S DEEPEST WELL

The world's deepest well, the No. 1 E A Baden Unit, bottomed out at 30,050 ft. in Viola limestone last month. Lone Star Producting Co. decided against continuing to its objective, a test of Arbuckle dolomite; the estimate for total cost of the well is $6 million. The record may not stand long – Western States Producing Co. is drilling to 31,000 ft. near Pampa, Texas.

INDEX TO CURRENT GEOLOGIC MAPPING PROJECTS

The Pennsylvania Geological Survey and the U. S. Geological Survey are currently engaged in many geologic mapping projects in Pennsylvania. The index map below shows areas where our field parties are working. In addition, five reports not included in the index maps in volume 3/2, pages 6-7, of "Pennsylvania Geology" are shown by heavy lines. Information on the areas being mapped may be obtained by contacting the Survey's offices.

The combination of the index map presented here and the index maps of published reports in volume 3/2 of "Pennsylvania Geology" give a reasonably complete picture of the publicly available detailed geologic mapping in Pennsylvania.

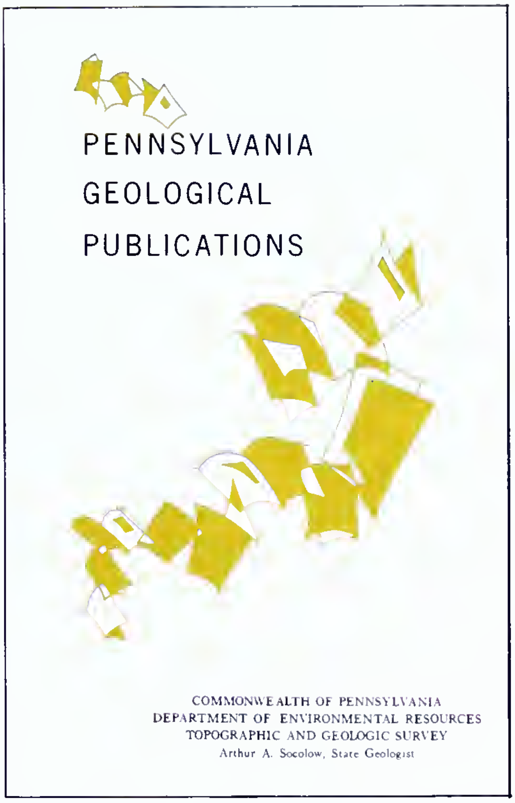

Pennsylvania Geological Survey
United States Geological Survey
Heavy line indicates recently published report

Quadrangle Geologic Mapping Currently in Progress
(Scale 1:24,000, except as noted)

NEW DIRECTORY OF GEOLOGY PUBLICATIONS

A comprehensive, new directory entitled, "Pennsylvania Geological Publications" has just been released by the Topographic and Geologic Survey of the Pennsylvania Department of Environmental Resources. This publication is a complete listing of all reports ever published on Pennsylvania geology by the Pennsylvania Geological Survey as well as the U. S. Geological Survey and the U. S. Bureau of Mines.

The new, comprehensive directory will be helpful to a wide range of people, whether they seek information on the general geology of Pennsylvania, or more detailed and technical knowledge of the geology of specific areas or specific topics. Water resource reports, mineral resource reports, maps, information circulars, environmental geology reports, geologic quadrangle reports, and the popular Educational Series and Park Guides are among the major catagories of publications listed.


PENNSYLVANIA
GEOLOGICAL
PUBLICATIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

An annotated index map as well as county and commodity cross-references are included in the new publication so that any reader interested in a particular area of the state or a particular subject may rapidly discover the geological reports that are available. Instructions are given telling how and where to write to obtain copies of all reports in print. A page is also devoted to instructions for ordering topographic maps of Pennsylvania.

To obtain a free copy of "Pennsylvania Geological Publications" write to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, Pennsylvania 17120.

THINGS IS THINGS

From Little Rock came the following morsel addressed to the State Geologist:

Dear Pen-Pal,

I am studying your state. Would you please send a little box of things from your state? I will send you a box of things from Arkansas. I go to Wilson School. What school do you go to?

Your Pen-Pal,
R. W.

FAULTING REVEALED IN THE NORTHERN PENFIELD AREA, CLEARFIELD COUNTY

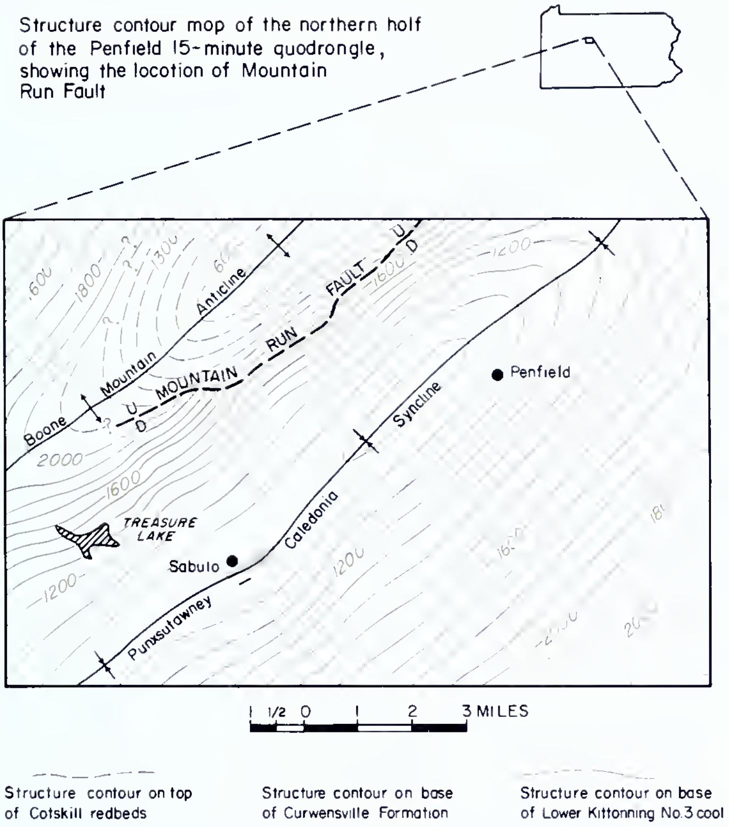
As the national demand for energy resources continues to rise, particularly in regard to oil and gas, we are witnessing a continuing demand for accurate structural geologic maps in Pennsylvania. Oil and gas are frequently found in traps formed by structural deformation, particularly folding and faulting, of oil- or gas-bearing strata.

Recently completed geologic mapping by Pennsylvania Survey Geologists T. M. Berg and A. D. Glover in the northern half of the Penfield 15-minute Quadrangle in Clearfield and Elk Counties has confirmed the existence of a high-angle reverse fault at the surface called the Mountain Run Fault that has up to 400 feet of displacement and can be traced for at least seven miles. This kind of fault, rarely seen at the surface in western Pennsylvania, is located on the southeastern flank of Boone Mountain (Sabinsville) Anticline. The fault trace is roughly parallel to the axial trace of folds in this region. Evidence for this fault is not obvious at the surface, and there is no outcrop of the fault plane, but there appears to be some topographic expression of a fault zone. Undisputed evidence for faulting comes from numerous shallow and deep gas wells. By plotting the subsurface occurrence of the top of the Catskill red beds ("red rock" of driller's terminology), it is evident that there is an offset of this stratigraphic horizon that is too abrupt to be explained by folding or sedimentological variations.

Deep gas wells on the flanks of Punxsutawney-Caledonia Syncline in this area and in the southern half of the Penfield 15-minute Quadrangle, show that the Oriskany Sandstone which is the principal producing horizon, is repeatedly offset, indicating extensive faulting. Faults at the Oriskany level, much deeper in the subsurface than the Catskill red beds, are thought to be related to movements along deep décollement or detachment slip surfaces as splays that rise up through the strata, becoming high-angle reverse faults dipping toward syncline hinges. None of these reverse faults have been mapped at the surface and we have assumed that displacement was dissipated in the thick marine Devonian beds.

Although the Mountain Run Fault probably originated in the same manner, it is unusual not only in that it occurs at the surface, but also in that it is apparently non-planar and dips toward the anticlinal hinge. If it were planar, the fault trace as it has been mapped, would indicate a very low-angle (8°±) fault. Non-repetition of stratigraphic units in the subsurface records negates low-angle thrusting. Although the relative movement of blocks on either side of the fault plane is known, the dip of the plane is not certain, making the fault difficult to classify. The upthrown block lies on the northwestern side of the fault with a maximum displacement estimated at about 400 feet near the northern edge of its presently mapped extent. If the fault surface dips towards the Punxsutawney-Caledonia Syncline to the southeast, the fault must be a **normal** fault. **Normal**

Structure contour map of the northern half of the Penfield 15-minute quadrangle, showing the location of Mountain Run Fault

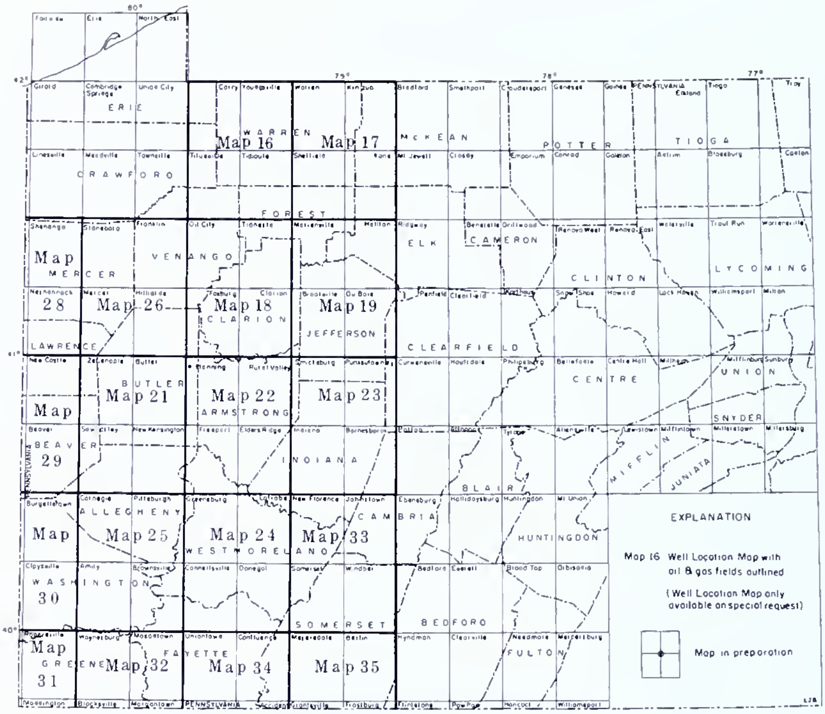


Structure contour interval equals 100 feet

faulting occurs when the overlying block moves **down** the inclined fault plane relative to the underlying block. If the fault surface dips toward Boone Mountain Anticline to the northwest, the fault must be a **reverse** fault. Reverse faulting occurs when the overlying block moves **up** the inclined fault plane relative to the underlying block. To our knowledge, normal faulting does not fit any of the known or theoretical structural patterns in this part of the Allegheny Plateau. We prefer to classify the Mountain Run Fault as a steeply dipping, almost vertical, reverse fault at the surface, with the irregular fault plane gradually curving down through the subsurface, intersecting the axial plane of Boone Mountain Anticline, and ultimately merging with the décollement slip surface at great depth.

One other fault like the Mountain Run Fault has been mapped by M. N. Shaffner (Pa. Geol. Survey, Atlas 57) in the New Florence 15-minute Quadrangle, Westmoreland County, Pennsylvania. It is important that this type of structure be documented now, especially since similar, but unmapped faulting of this nature may affect the occurrence of our energy resources.

Thomas M. Berg



NEW AND UPDATED OIL AND GAS BASE MAPS

The above index map shows the oil and gas base maps that are now available. Numbers 34, and 35 are new as of June 1, 1972. Numbers 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 28, 30, 31, 32, 33 have been updated (posted date June 1, 1972). Paper prints of these maps, which show the locations of all the wells drilled for oil and gas since 1956 with gross field limits, can be obtained by writing to Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Cost of each map is $0.50, plus 6 percent state sales tax. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering, please specify the map number.

WE GIVE TILL IT HURTS

A Philadelphia friend sent this one:

Dear Sir Mr. Arthur Socolow,
Will you please send me some molecules and a microscope.
Thank you,
M. C.

Since we had more molecules than microscopes on hand, we sent some of the former.

SURFACE TO MIDDLE DEVONIAN STRATIGRAPHY OF PENNSYLVANIA ON OPEN FILE

The Pennsylvania Geological Survey has placed on open file a new report on Surface to Middle Devonian Stratigraphy. The new report consists of a short text and eight gamma-ray log cross sections whose locations are shown in the above figure. The cross section interval is from the surface to the base of the Upper Devonian shallow oil and gas sands.

The purpose of these cross sections is multifold:

1. To establish regionally consistent correlations and to delineate prominent reservoir zones and marked changes in thickness and facies.
2. To indicate occurrence of fresh and salt water where reported in the vicinity of control wells and to mark the position of prominent coals, limestones, clays, and other resources.
3. To reproduce gamma-ray logs at the same vertical scale (1 inch to 100 feet) as commercially available geophysical and sample logs, thus enabling direct correlation of our regional cross sections with currently available commercial data.

The cross sections form a basic reference network of geophysical logs for subsurface investigations. These investigations may be directed toward oil and gas reservoir distribution, subsurface disposal of effluent wastes, sources of brine or fresh water, potential migration of pollutants, or the distribution in the near subsurface of exploitable resources such as coal, clay, limestone, dolomite, aggregate, and other construction material.

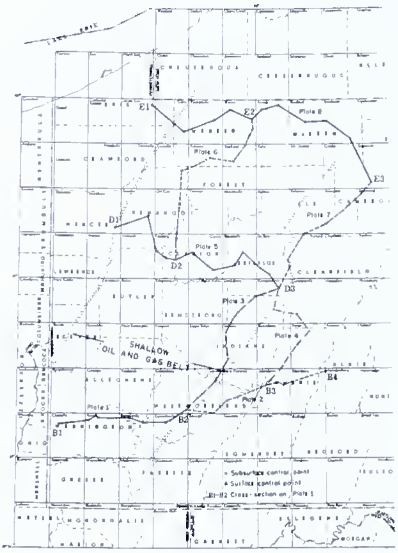
The selection of specific gamma-ray logs used in these sections was difficult. Some short logs of very shallow wells best exhibit the near surface stratigraphy whereas good illustrative deep well logs commonly lack significant detail in the near surface rocks. Date of logging, areas of recent or past subsurface inactivity, and geographic and stratigraphic location are other factors that prohibited the optimum selection of all logs. Hopefully these cross sections will stimulate adequate logging of holes in areas where data are scarce, and will encourage the release of existing logs and other information in these areas.

The cross sections are divided into major "Zones" and subordinate "Units" which can be correlated throughout western Pennsylvania. Near surface Zones—Dunkard, Monongahela, Conemaugh, and Allegheny—are equivalents of surface groups of the same name. Stratigraphically below these groups the terminology and boundaries of some units are less well-established and locally controversial. Consequently, we have established the following informal Zones for reference: Pottsville-Burgoon, Middle and Lower Pocono of Carboniferous age, and Zones D, C, B, and A of Late Devonian age. Zones D and B contain beds of sandstone and are productive of oil or gas whereas beds of sandstone are scarce or absent in Zones C and A. These are the same Zones used in PR 178 "Representative Gamma-Ray Logs from Shallow and Deep Wells", where the Zones are shown in detail.

Zones are further subdivided into Units. The thick Pottsville-Burgoon Zone of southern Pennsylvania contains three Units: Pottsville Group, Mauch Chunk Formation, and Big Injun Unit. Zone D has Units D3, D2, D2b, D2a, and D1. Zone B is subdivided into Units B4, B3, B2, and B1. The Units are the productive oil and gas sands in the Zones.

The top of the Warren First Sand or its lateral equivalent was selected as the principal datum because it is a widespread marker in the northern two-thirds of the area studied, and is present throughout the western Pennsylvania Plateau. The datum marks one of the major changes in the stratigraphic column in the northern cross sections.

Although the gross stratigraphic pattern of Zones and Units is one of relative uniformity or gradual change, the cross sections clearly illustrate the rapidity of local variations in thickness and facies within Units. These changes make correlation difficult and are a major cause of miscorrelation of reservoir beds and the resulting confusion of terminology of oil and gas sands. Within units, the variations in lithology and bed thickness are most important in defining and delineating near surface fresh water reservoirs, coals, clays, and limestones or deeper subsurface oil, gas, and disposal reservoir. The consistent thickness of the larger lithic groups offer a framework for unravelling the details of the individual stratum of economic importance.



The report is on open file at the Pennsylvania Geological Survey, 401 Pittsburgh State Office Building, 300 Liberty Avenue, Pittsburgh, Pennsylvania 15222. It is available for examination at the above office and copies of the report will be made available at the expense of the individual.

GAS RESERVES DOWN

The American Gas Assn. reports that U. S. proven reserves of natural gas were reduced to 278.8 trillion cu. ft. at the end of 1971 – down from 290.7 trillion cu. ft. in 1970. The AGA, an industry organization whose figures are used by the Federal Power Commission, said that reserves in the lower 48 states fell to 247.4 trillion cu. ft., the lowest since 1957. AGA president F. Donald Hart announced that total reserves, including Alaskan estimates, are lower than in 1964, while demand has increased nearly 45%.

SURVEY ANNOUNCEMENTS

THREE GEOLOGISTS JOIN SURVEY STAFF

The Pennsylvania Geological Survey is pleased to welcome three new geologists to our staff.

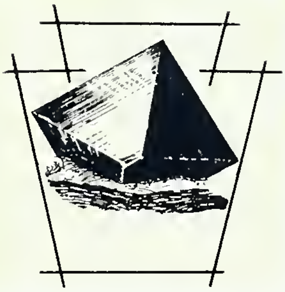
Bernard J. O'Neill has returned to the Survey after spending several years with Foote Mineral Co., Inc. as an exploration and economic geologist. "Buck" O'Neill's wide-ranging background in mineralresources, his familiarity with Pennsylvania geology and its industry, and his previous experience at the Survey will be invaluable to us. His current research is primarily concerned with the utilization of shales and clays from southwestern Pennsylvania.

Robert C. Smith II comes to the Survey via Lafayette College and Pennsylvania State University where he has recently completed a Ph.D. thesis on the geochemistry of diabase in Pennsylvania. Bob also has completed research on lead-zinc occurrences and rare-earth pegmatites, all in Pennsylvania, and is a specialist in the field of analytical techniques. His modern research abilities and experience in Pennsylvania geology will, in his future research, add much to our knowledge in the fields of geochemistry and metallic mineralization.

Jesse L. Craft, Jr. has joined the staff of the Pennsylvania Geological Survey at the Survey's Pittsburgh branch office. Jesse, assigned to the Environmental Geology Division, will be responsible for carrying out the Division's goals and objectives throughout western Pennsylvania. In addition, he will work closely with the Survey's growing committment to the "Greater Pittsburgh Regional Studies Program" which aims to enumerate the environmental geology factors of the six-county area around Pittsburgh. Jesse received his B.Sc. degree from Sul Ross State College (Texas) and his M.Sc. degree from Syracuse University. He is currently a Ph.D. candidate at the University of Western Ontario (Canada). Jesse's professional experience includes several years with the U.S. Army Urban Intelligence Research Team, geology instructor at Brock University, and geology laboratory supervisor at Carleton University. His Ph.D. dissertation research experience has been in stratigraphy and geomorphology of the High Peaks Region in the Adirondack Mountains of New York. Jesse has written 13 published papers and abstracts and is a member of several national, professional societies. Jesse and his wife will reside in the Pittsburgh area.

MARBLE

Marble was first quarried in Italy in 283 B.C. Roman emperors developed a passion for marble, and Augustus boasted, "I found Rome of unbaked brick and left it of marble".



EARTH SCIENCE TEACHERS' CORNER

pennsylvania earth science teachers society (pests)

The Pennsylvania Earth Science Teachers Society has unusual call letters but they like it that way. They hope to be friendly pests in the promotion of earth science education in Pennsylvania. That is their purpose and they plan to work to that end.

Several earlier meetings by a group of Pennsylvania earth science educators were followed by the constitutional meeting on May 6, 1972 at West Chester State College. At that meeting the general policies of PESTS were agreed upon and the new officers began immediately to set up programs to initiate these policies.

Pennsylvania is in the Eastern Section of the National Association of Geology Teachers. It was felt that this local section and the national association were too general to specifically aid Pennsylvania earth science education at local institutions. However, PESTS will work with the Eastern Section by sponsoring sectional field trips or programs in the fall of each year. These will be designed to familiarize earth science teachers with their local areas and opportunities. A general meeting will be held each spring to conduct business and present material pertinent to earth science education. One of the first projects now underway is an inventory of school districts in the state and the identification of those teachers involved in earth science teaching. The scope of earth science education in the state will be documented.

The constitution of the society has incorporated into it that of ten members on the board of directors, at least four will be school teachers and at least four shall be from higher education. This stipulation is included to prevent domination of the organization by any one group of educators and guarantees that each segment of the educational community will be heard. The executive committee which will lead the organization consists of the ten members of the board of directors and five officers.

PESTS expects to aid earth science educators in the following ways:

1. sponsor local programs and field trips each fall
2. sponsor a program and general meeting each spring
3. sponsor a state fossil, rock, and mineral exchange
4. create standards for state earth science teacher certification

5. catalog legislation concerning earth science in the state, and perhaps influence it
6. select the teacher of the year from Pennsylvania for the Eastern Section of NAGT
7. set up guidelines for an earth science curriculum
8. act as a clearing house for vacancies within the state
9. encourage institutions of higher education to establish programs for training earth science teachers
10. encourage all school districts within the state to include earth science education in their programs
11. coordinate earth science clubs around the state

In conclusion the Pennsylvania Earth Science Teachers Society is an organization designed to forward the course of earth science education within the state. We welcome members from all walks of life as well as educators from all levels of the academic community. Interested persons should contact Dr. S. Greenburg, Earth Science Department, West Chester State College, West Chester, Pa.

John Tomikel
California State College of Pennsylvania

new leaflets from the U.S.G.S.

Two new U. S. Geological Survey leaflets have been introduced to their popular geology series, and you might say the emphasis this time is on the "environment".

"TOOLS FOR PLANNING – TOPOGRAPHIC MAPS", 15 pp.

"TOWARD A NATIONAL CENTER FOR THE U.S.
GEOLOGICAL SURVEY", 11 pp.

These pamphlets are available free of charge from the U. S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia, 22202.

NEW SUSQUEHANNA BOOK

A new book has just been issued which will be of interest to many Pennsylvanians and friends of the Susquehanna River. **The Susquehanna Compact: Guardian of the River's Future** is by William Voigt, Jr. who was Executive Director of the Interstate Advisory Committee on the Susquehanna River Basin from 1963 to 1968 during which time the Compact was drafted and passed by the three-state legislatures.

Written in a folksy, easily-read style, the book is loaded with important information and background "color" on the needs, trials and tribulations, and results of the Compact development.

The Susquehanna Compact: Guardian of the River's Future was published by Rutgers University Press and is priced at $15; it is sold through retail bookstores.

MEET THE STAFF

Davis M. Lapham, Chief Mineralogist

Davis M. Lapham joined the Survey staff as mineralogist in 1957. At that time, the Survey began an expansion of its staff and facilities, one aspect of which involved the setting up of modern laboratory facilities. Since then, Dr. Lapham, as Chief of the Mineral Resources Division, has supervised the Survey's laboratories and the geological research concerned with them.

Besides planning and guiding the research in his Division, Dave has been involved in numerous investigations of his own ranging from descriptive mineralogy for collectors, published as the Survey's popular "Mineral Collecting in Pennsylvania", to such topics as the occurrence and structure of rare minerals and the origin of diabase and associated magnetite ore. Pioneer work in the techniques of quantitative X-ray mineralogy has been applied to the utilization of clays and shales in Pennsylvania and Dave is continuing this study with other staff geologists. In addition, current work includes the application of radiometric dating to Pennsylvania geology and studies in the serpentinite area of Lancaster and Chester counties.

Dave was born in Glens Falls, New York, obtained his A.B. degree from Middlebury College in Vermont, and his M.A. in 1955 and Ph.D. in 1957 from Columbia University. In addition to his early hobby of mineral collecting throughout New York and New England, Dave worked for the New York State Geological Survey performing glacial geologic mapping, for the U.S. Atomic Energy Commission on Colorado uranium ores, and studied alteration effects in Canadian gold deposits. He is a member or fellow of numerous professional societies, recently was elected to the executive board of the Friends of Mineralogy, is in charge of regional abstracting for the International Mineralogical Association, and acts as a critical referee for several international publications. In addition, he has authored or co-authored nearly 50 articles and publications.

Dave lives outside New Cumberland with his wife, Nancy, and daughter, Heather. As he says, "It's a great place to live: right on top of the diabase contact where clusters or garnet crystals occur practically on my doorstep." Geologists never do seem to escape the clutches of their fascinating science, and Dave is no exception.

PENNSYLVANIA GEOLOGICAL SURVEY STAFF

Arthur A. Socolow, *State Geologist*
Donald M. Hoskins, *Assistant State Geologist*

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Albert D. Glover, *Geologist*
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In Cooperation with The U.S. Geological Survey

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In Cooperation with The U.S. Geological Survey

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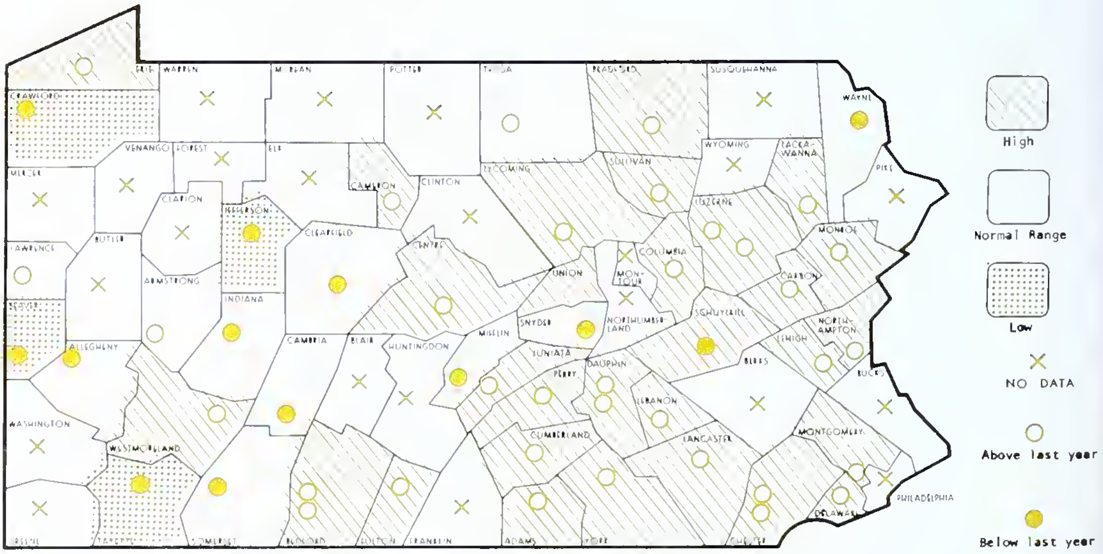
GROUND-WATER LEVELS



PENNSYLVANIA GEOLOGY

THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER — This is a view of the Survey building as the flood waters were rising. The intensity of the current which came on extremely suddenly, prevented rescue of any items until the waters receded.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

AUGUST 1972

FROM THE DESK OF THE STATE GEOLOGIST . . .

AGNES DEVASTATES PENNSYLVANIA SURVEY

The Pennsylvania Geological Survey has been subjected to destruction unparalleled in its 136-year history.

On June 21 it began to rain. In the next 4 days the tropical storm Agnes dumped 16 inches of water on central Pennsylvania. The Susquehanna River reached a crest of 16.5 ft. above flood stage at Harrisburg, Pennsylvania, on June 24. This spelled disaster for the Survey, which, occupying the entire ground floor and basement at its custom-designed new quarters, saw the water reach 12 ft. at its site, well above the ground-floor ceilings.

When we finally waded in, we were dumbfounded by the havoc. Nothing was left intact. A black, pitch-like layer of industrial oil on top of 2 to 3 inches of silty muck covered everything. Furniture was in a jumbled tangle as desks, chairs and wooden cabinets had floated and flipped, dumping all top contents. The acoustical-tile ceiling had dissolved into oatmeal-like mush. In the exposed spidery network of the suspended ceiling hung entangled furniture, manuscripts, notebooks and records. Plywood walls lay in contorted shapes, and plasterboard partitions had simply sagged to the floor. The outer offices, with their large glass windows, left little to salvage, as the weight of the water had burst through and flushed all belongings out; some desks were found 2 miles downstream, and other items now line the floor of Chesapeake Bay. Our map room, lined with proud new wooden map cases, looked as if a giant had built a mountain of jumbled blocks; it was a total loss. As the water soaked through file cases (including air photos for 700 quadrangles) the contents expanded and burst the fronts of each drawer. Office bookcase exhibited weird patterns of deformation as water-soaked books had swelled up and pushed through the sides of the cases.

The wreckage of the chemistry lab with the pools of intermixed reagents would have done credit to a fictional fiend. The wreckage of the X-ray and microscope labs would bring tears to the eyes of any scientist.

Continued on page 2

In terms of totality of loss, our library of nearly 40,000 volumes suffered the worst. It was in an interior room and we could not get to it for several days. Having moved just a few weeks before, our books were still packed in a big pile of cartons. When we did get in to them we found that expansion had burst every box and we faced a massive mound of 40,000 volumes covered with dissolved glue, mud, and industrial oil. By that time most of the books were well on their way of returning to pulp.

We are now in temporary quarters striving to pull ourselves together. The staff has worked fiendishly to salvage what we could. We got great help from some of our geologist friends who worked with us side by side in the muck. Particularly we must acknowledge help from the staffs at Dickinson, Lehigh and Penn State. A few of the instruments we have salvaged—at least well enough to be sent off for factory rebuilding. Our top-priority manuscripts we fished out of the muck and rushed to Bill Heintz (of Williams & Heintz Map Corp.) who generously offered to wash and dry them. Most equipment and furniture we shall have to replace. Our records retrieved from the muck, were rushed to industrial freezers and later processed in the hay-drying ovens at Hershey Farms; they are now crisp.

As to our library—the core of our research capability—we must issue an appeal. Many items are just not on the market, so we would greatly appreciate it if anyone with surplus geological books or periodicals would forward a list of them to the Pennsylvania Geological Survey. We will check off only the ones we need and make arrangements for shipment.

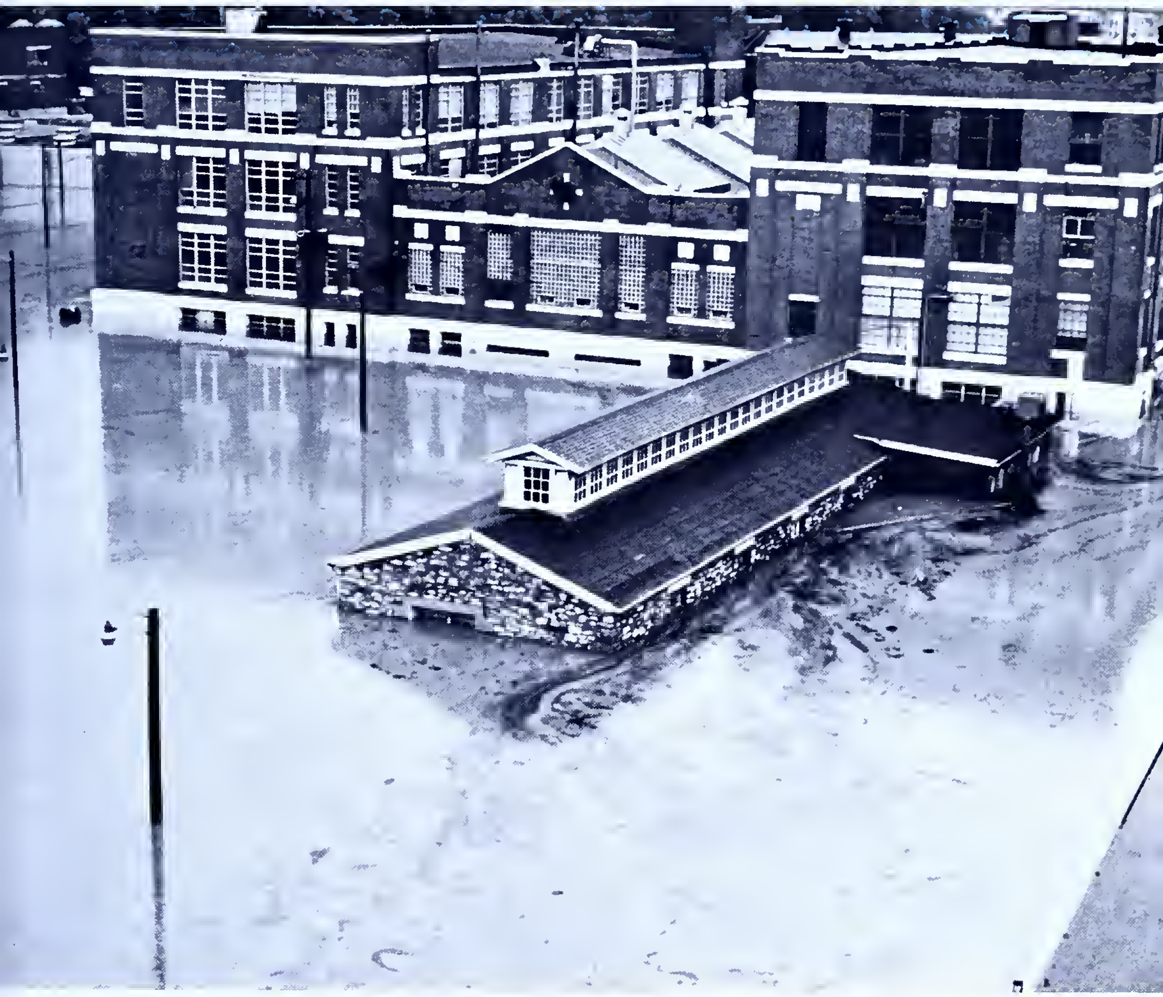
The Pennsylvania Survey will rise again, but we need the help and patience of our friends and patrons.

Arthur A. Socolow

AN EXPLANATION

For the past few years the August issue of the Pennsylvania Geology Bulletin has carried our annual NEWSLETTER in which we list all the ongoing geological projects in Pennsylvania. We had planned the same this year and the annual questionnaire had been distributed, received, and compiled. Came the flood! All the returned questionnaires were completely lost. So we are going to skip the NEWSLETTER issue this year, but we'll have it again for you next year. Sorry, but we trust you appreciate the problem.

A PICTURE STORY OF THE FLOOD



Near the peak of the flood our main building and the outer warehouse showed little left of our ground floor quarters.

peak flood level,
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ground floor. The
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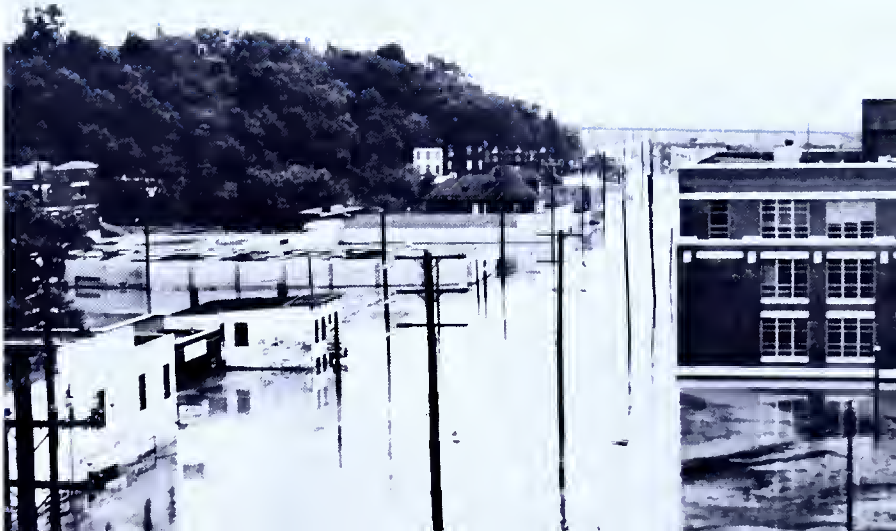


The oil saturated Survey building became a graveyard of devastated furniture and equipment. Acquired with difficulty over the years, in one fell swoop it ended up as landfill material.

One end of the map room looked like this after the flood. On the cases are the remains of a stock of new topographic maps received before the flood. Over 200,000 maps were ruined.

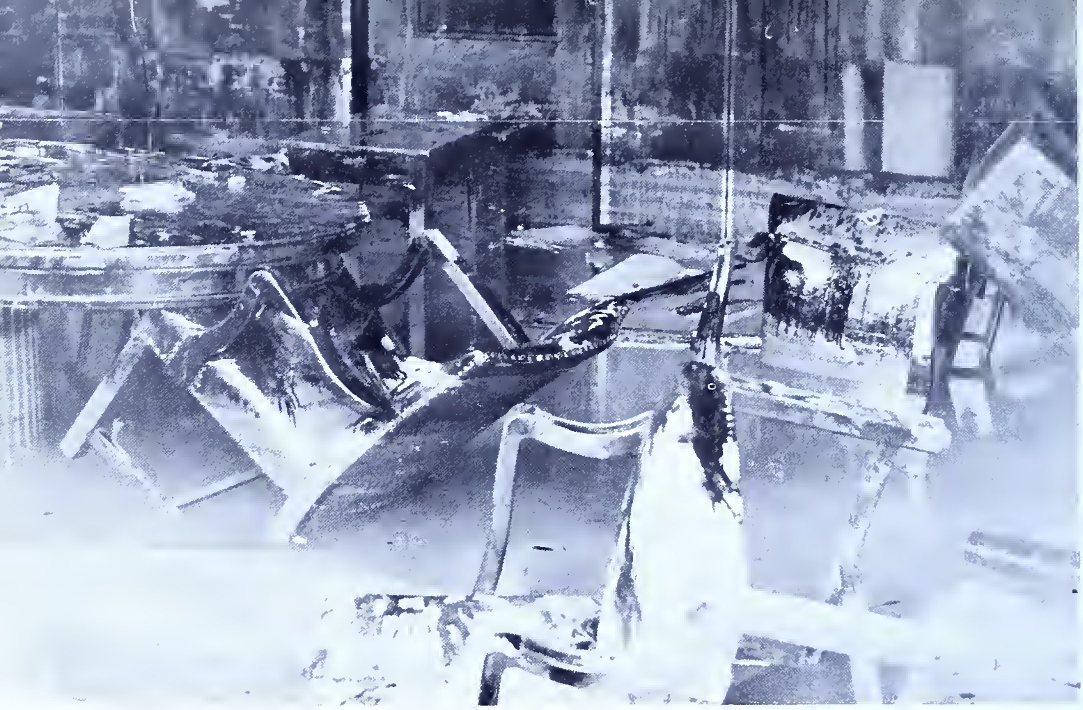
Our new map cases loaded with topographic maps were tossed about by the flood and left in a jumbled heap.

One end of the library showing the havoc among the photo files. Water level higher than the ceiling dissolved the tiles, leaving exposed the struts of the suspended ceiling.

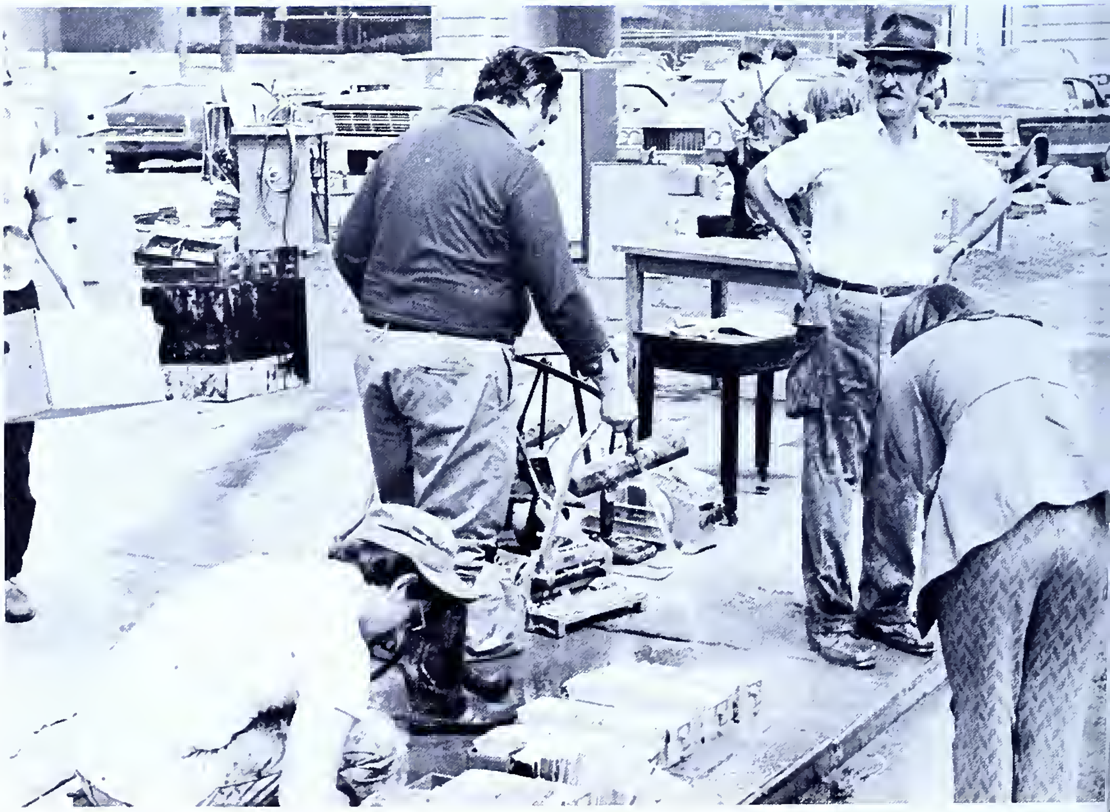
The stock of surplus library books got hit hard. There were no surplus books left after the flood. Oil, silt, and mud ruined the entire library.

Student assistant Kim Bodoia finds access to the map files somewhat restricted.

The furniture was a total loss, but our manuscripts in progress and our administrative records, we were determined to save. Here Arthur Socolow, Bert VanOlden, and Don Hoskins pass boxes of the mud-covered, oil-soaked materials out the demolished windows, to be sent to freezers to prevent decay.



These oil soaked shambles were once the State Geologist's neat, white-walled office.



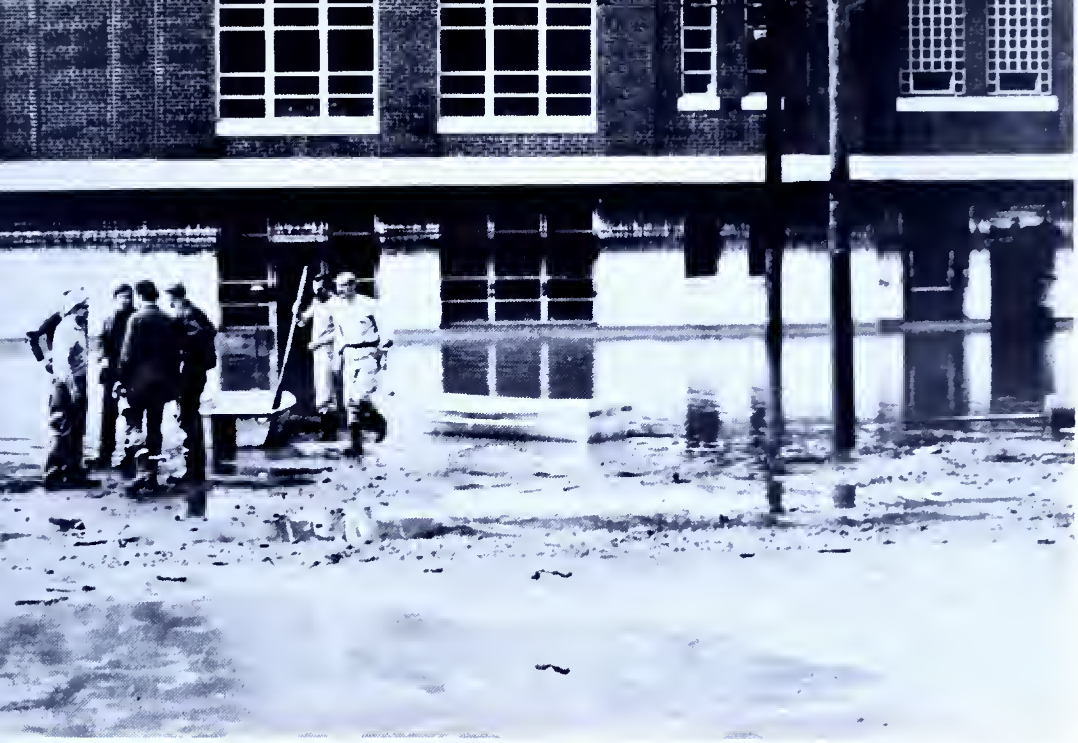
Here Assistant State Geologist Donald Hoskins takes a breather to survey some of the few items which were saved. Arthur Socolow washes the library card files — at least we have a record of what we lost.

A sad sight faced us when we got into the geology library. Our books, which had still been in cartons from our recent move, had turned to an oil and glue covered mass of pulp. A total loss of nearly 40,000 volumes.

Through a window demolished by swirling waters, Environmental Division Chief Alan Geyer points to the oil saturated remains of his office.

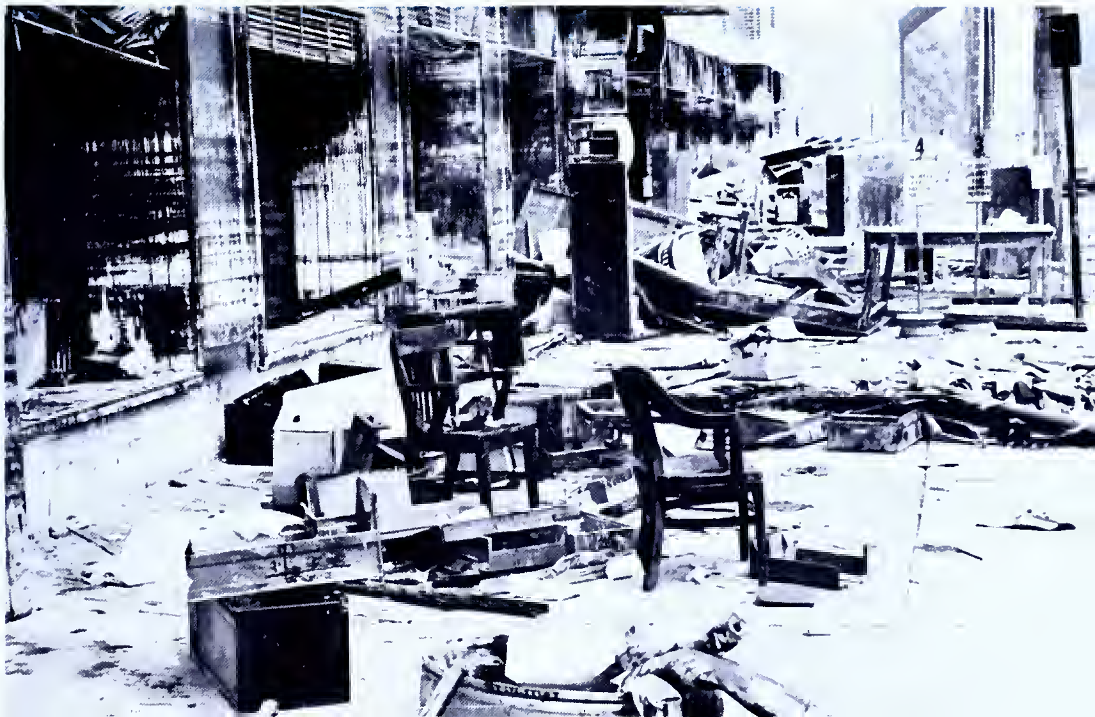
A collection of map tubes fared poorly in the oil and muck.

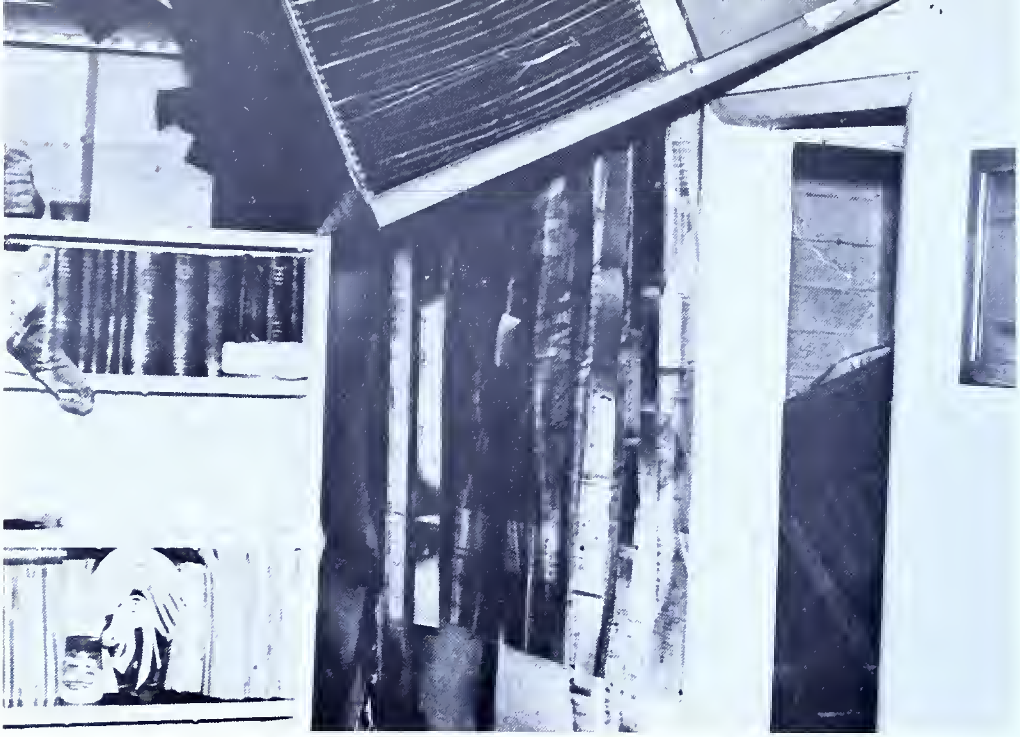
Geologists Bill Sevon and Don Hoskins compare notes on salvage operations as Art Socolow, with phones out of commission, had to use walkie-talkie to get messages out.



The boats were a help in salvage work before the water completely receded. The oil line shows total submergence of our ground floor quarters.

Survey office building after the battle! It looked like it and felt like it.



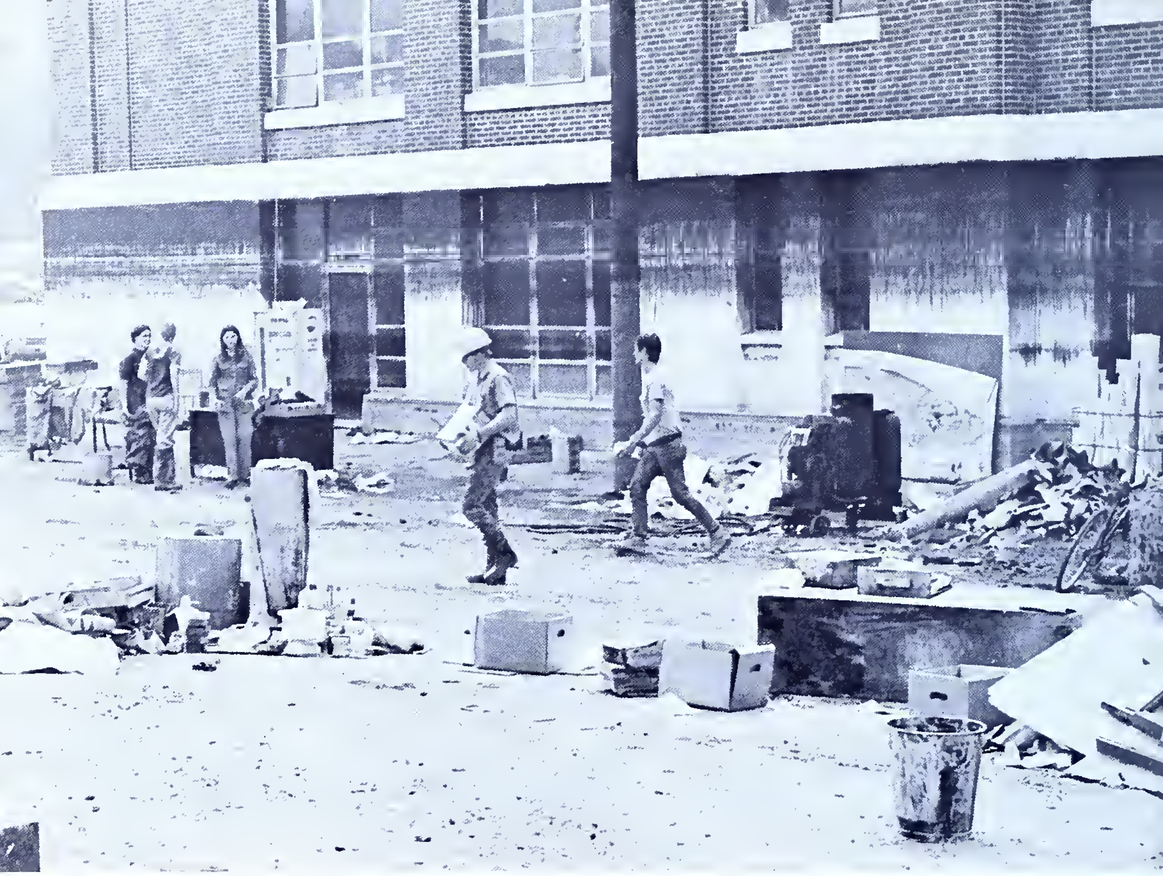


Twelve feet high waters carried a file cabinet into the ceiling struts and left it hanging there.

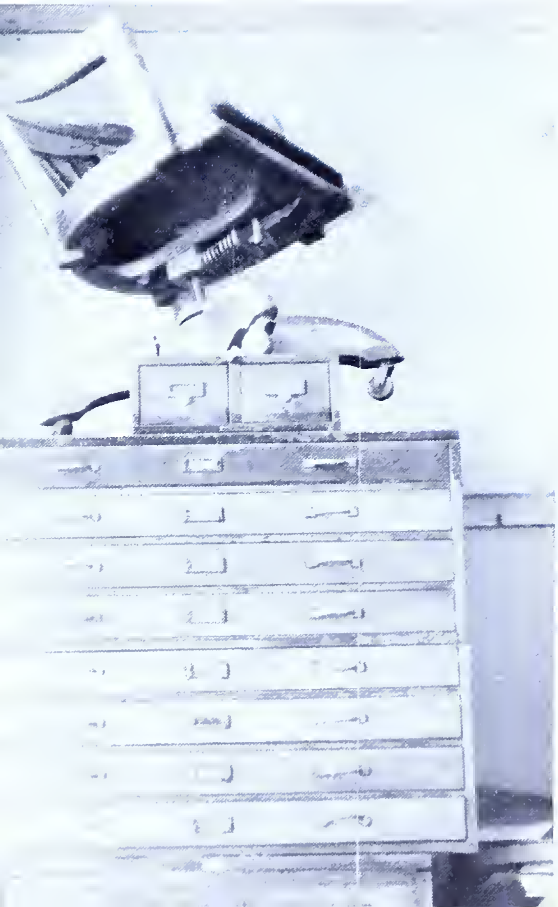
Geologists Bill McGlade and John Way helped to clean up some of the electronic lab equipment in the hopes of salvaging these valuable items.

Our electric typewriters did not fare well. Only three out of 24 were repairable. Unlike ball point pens, they don't do well under water.

Geologist Dave MacLachlan retrieves some of his records even as the flood waters still abound.



As salvage progressed, it was a tough job keeping the piles of junk material separate from the piles of "to be saved" items.



This photo was not a setup. The chair actually floated up there and was left stranded on the cabinets.

There was even an artistic side to the flood disaster. These are swirling oil stains left on our building columns.

One had to look in all possible and impossible places for salvage. Here a manuscript in Editor Wilshusen's office was actually left stranded on a light fixture close to the ceiling.

Bert VanOlden, Arthur Socolow, and Barbara Conrad are washing down some library records prior to rushing them off to a freezer for preservation. The entire staff worked diligently to salvage critical items.

The stock of our educational geology booklets in the outside warehouse had to be shoveled out and became part of the new landfill of the area.

Chief of the Field Division, Sam Root, uses his back lawn to lay out and dry his project maps.

Survey Librarian Sandra Blust, in the uniform of the day, stands at the oil soaked front of the Survey quarters to help retrieve some important documents.

Buck O'Neill was drying out some of his mineral deposits maps after the holocaust.

This was not our Monday wash line. It was our Monday manuscript line — hanging out to dry in our parking lot.

Outside our ruined, oil coated building, staff geologist Rick Wells strung a clothesline to dry his field project maps and sections.

Our X-ray equipment was pulled out and cleaned in the hopes of salvaging some of its components.

Our geologists take a breather during salvage work. Left to right: Troutman, Bodoia, Bragonier, Berg, Glover, and Hoskins.

Free parking overnight in our parking lot did not pay off for this car.

THE FLOOD AND THE SURVEY

The flood caused by hurricane Agnes in June of this year resulted in crest waters of 32.57 feet at Harrisburg. This meant that the entire facilities of the Pennsylvania Geological Survey at 100 N. Cameron St. in the Paxton Creek lowland were inundated completely to the ceilings. Damage by flooding was extensive and in many forms not anticipated. Everything was wet, obviously. Almost everything exposed was coated with mud. But some of the places where mud was deposited were almost unbelievable: between the pages of books packed on shelves; inside multi-lens microscope objectives and occulars; inside Brunton compasses; on papers in files in closed drawers, etc. Although some things were damaged by movement during the flood, much damage occured as the flood waters dropped and sedimentation of moved materials occurred. Unquestionably the most shocking and visual damage came from the large amounts of oil which literally coated everything in the front of the Geological Surveys ground floor headquarters. Oil found its way into all parts of the building. Other types of damage, many of which are illustrated by the pictures in this booklet include: wooden items, such as desks and tables, floated and dumped everything on their top, such as lamps, books and even a Programma 101 computer; chemicals were spilled; windows were broken. The Assistant Director's desk was floated out his office window and carried several blocks downstream from the building. Some field notebooks containing data representing many months and even years of work were washed away and never found. Even more startling were tightly packed books which swelled with water and bent metal bookcases outward at both ends. Air photographs swelled and wedged open the fronts of locked file drawers; acoustical ceiling tile floated, disintegrated and made a sticky mess wherever they were deposited; numerous maps and papers were buried in the mud and debris and never recovered; wooden desk drawers swelled and could be opened only with axes and crow bars; expensive electronic and other electrical equipment was virtually made worthless. These are the destructive effects of hurricane Agnes which were witnessed. As is well known, this flood was a major catastrophe, particularly to those who work and live in the Susquehanna River basin.

Flooding in the Susquehanna River basin was severe. Those areas reserved by nature to accommodate excess water, the flood-plains, were inundated in many places to depths never experienced since these regions were settled in the 17th century (Figure 1). Some places, like Wilkes-Barre, were almost destroyed. At Harrisburg, the Paxton Creek lowland became again a channel of the Susquehanna River and Harrisburg Island existed again temporarily (Figure 2). We say that areas again became flooded because such events (disasters), though freaks of nature in a man's short life span, are in reality a part of the predictable and clearly evident history, past and future, of the Susquehanna River basin.

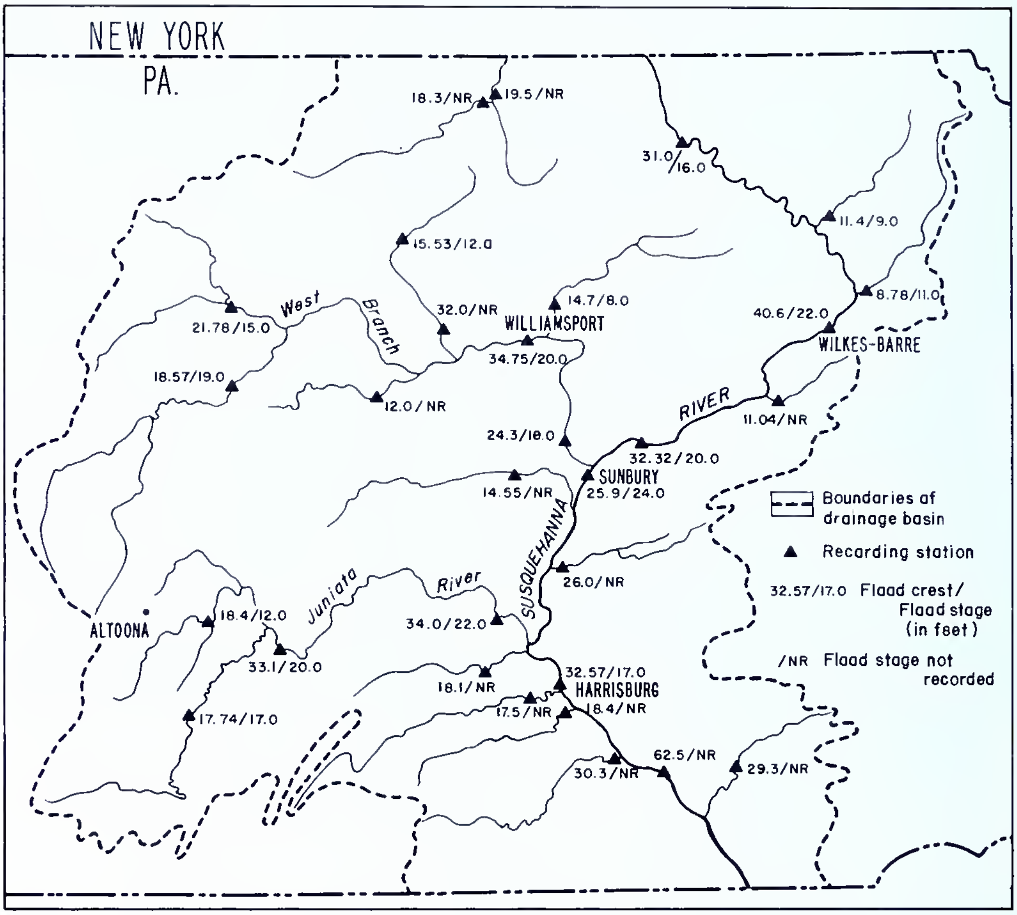


Figure 1. Flood crest and flood stage heights (in feet) at selected recording stations in the Susquehanna River Basin. Data is preliminary information, supplied by Geological Survey-Water Resources Division, Harrisburg, Pa.

The Geologic Reasons For Flooding

During the last several million years, the landscape of Pennsylvania has been slowly evolving through the processes of erosion and glaciation. Much of this area is part of the Susquehanna River drainage basin and the landscape is intimately related to that river and its many tributaries. Much of the northern part of the drainage basin bears the marked imprint of glaciation but the southern part has changed only subtly during the last million years. Since the 17th century the extensive human settlement in the basin has mainly effected only the surface characteristics of the drainage basin, generally in terms of land use. The effects of the 1972 hurricane Agnes upon the influences and changes, both geological and man-made, in the Susquehanna River basin and its impact upon the Pennsylvania Geological Survey are the subject of this bulletin.

One of the subtle changes wrought in the landscape by the slow process of landscape evolution through river erosion has occurred at Harrisburg, Pennsylvania. Within the last million years the Susquehanna River bed was 20 to 30 feet higher than at present. After flowing through the confinement of the Susquehanna Water Gap in Blue Mountain north of Harrisburg, the river previously occupied a much wider channel than now and surrounded an island area where the city of Harrisburg now sits. The situation then was almost identical to the situation experienced at Harrisburg during the recent flood (Figure 2) except that then, because the river bed was higher, the broader channel and island existed during normal flow conditions as well as during flood conditions. Gradually the river eroded its bed. Greater erosion occurred in the western channel than in the eastern channel and eventually the Susquehanna River abandoned the eastern channel and what was Harrisburg Island joined the east bank by a lowland area now occupied by a small stream, Paxton Creek.

The Paxton Creek lowland was flooded periodically by the Susquehanna River, but this tendency apparently decreased as the river to the west continued to erode and lower its base level.

As extensive human settlement of Pennsylvania progressed, the surface of the land throughout the Susquehanna River drainage basin was changed to meet the needs of man: agriculture, home sites, transportation systems, etc. Most of these changes resulted in deforestation, lowered rainfall retention, increased runoff and consequent increased flood potential in such areas as the Paxton Creek lowland. The man-influenced environment was thus prepared and had proved itself no longer a natural baffle to floods in 1936 when the Susquehanna River flooded the Paxton Creek lowland.

Throughout man's development of the Susquehanna River Basin, he has, for one reason or the other (economic, convenience, esthetics or willful disregard of nature), extensively developed land subject to the occasional ravages of the river and its tributaries. Many communities, such as Wilkes-Barre and Sunbury, have been built almost entirely on floodplains. The Paxton Creek lowland at Harrisburg is now occupied by housing, industries, office buildings and retail stores.

The Flood

On April 17, 1972, after 53 years of residence in various places on the old Harrisburg Island, the Bureau of Topographic and Geologic Survey completed a move to new quarters on the ground floor of 100 N. Cameron Street, an office building in the Paxton Creek lowland. The west side of the building was immediately adjacent to the present channel of Paxton Creek.

April, May and early June were wet months in the Susquehanna River drainage basin and ground water tables were already high. The situation was within normal limits on a long term basis and in keeping with long term cyclic rainfall fluctuations (drought years and wet years). Moderate to heavy rainfall in the upper Susquehanna River basin prior to June 21 caused some flooding in New York State and increased drainage into the Susquehanna River. And then came Agnes.

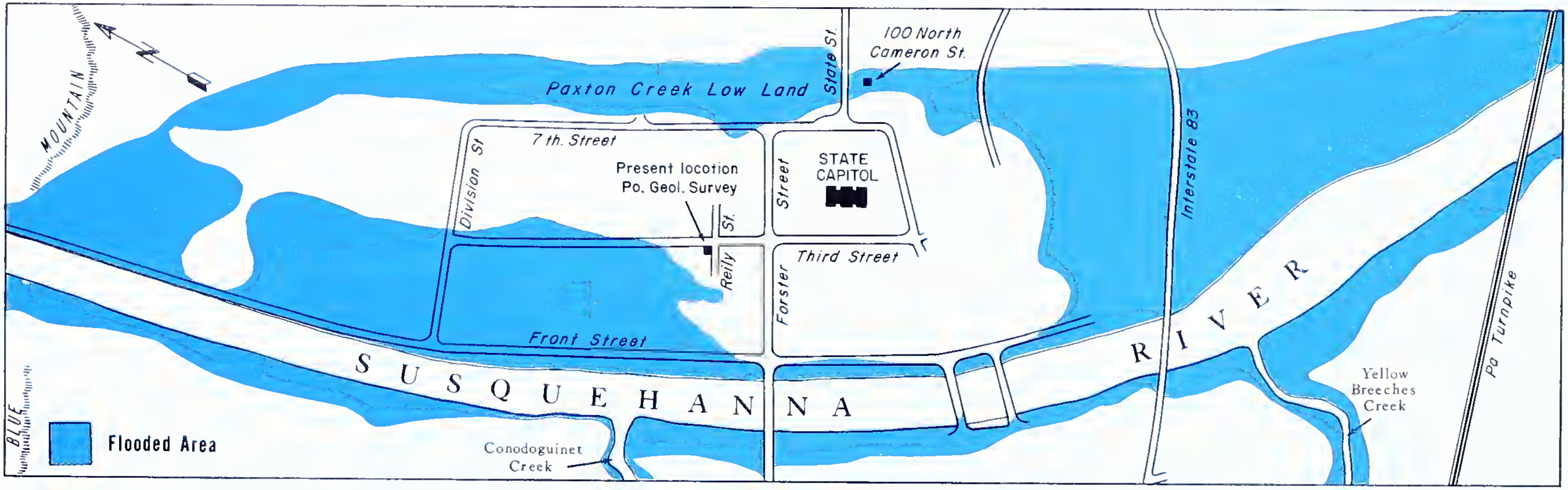


Figure 2 Map Showing Area of Harrisburg Flooded in June, 1972

Hurricane Agnes arrived in Pennsylvania on June 21st where she moved slowly. The result was the large amounts of rainfall shown in Figure 3. Because of the low water absorption capacity of the Susquehanna River drainage basin created by long term influence of land use and short term effects of high water tables, copious runoff developed and large quantities of water ran into stream channels.

Flooding represents the natural accommodation in the stream valley of great quantities of water which exceeds the capacity of the normal stream channel. Such accommodation (flooding) is normal and repetitive. The excess water in its downstream rush simply spreads out onto the flood plain and may eventually fill the entire stream valley. The increased amount of water results not only in a rise of water level, but also an increase in flow rate and carrying capacity. As the flow rate increases, a stream which during normal flow may be able to transport only silt and clay size material (mud) may reach such high velocities that rocks the size of bowling balls and even snowmobiles can be swept along. In addition, the increased stream volume and velocity cause the stream to carry a greatly increased amount of eroded materials such as sand, boulders, trees, and a great variety of other items which are not moved by a stream in normal flow conditions.

This load of debris causes varieties of damage to other objects, particularly stationary objects such as buildings, which happen to be in the path of the rapidly flowing currents. The moving debris combined with the increased velocity and carrying capacity causes the stream to severely damage by erosion not only its own banks, but also road beds, house foundations and agricultural lands.

Floods crest eventually and the water level begins to recede. As the water level drops, there is a decrease in velocity and carrying capacity of the currents and a resulting deposition of the materials being transported. It is during this phase of flooding that gravel deposits are formed on grass lawns and mud layers are formed on all surfaces. All of these aspects of flooding (water level rise, erosion, impact and deposition) are generally destructive to the works of man. Every flooded community within the Susquehanna River basin returned to find what devastation this flood had wrought. We at the Pennsylvania Geological Survey found that, physically, we had been almost destroyed.

Salvage

Salvage operations at the Survey commenced even before the flood waters were completely out of the building. Initially, salvage was hindered by the shock of the extent of damage, which was beyond expectation, and by the problem of

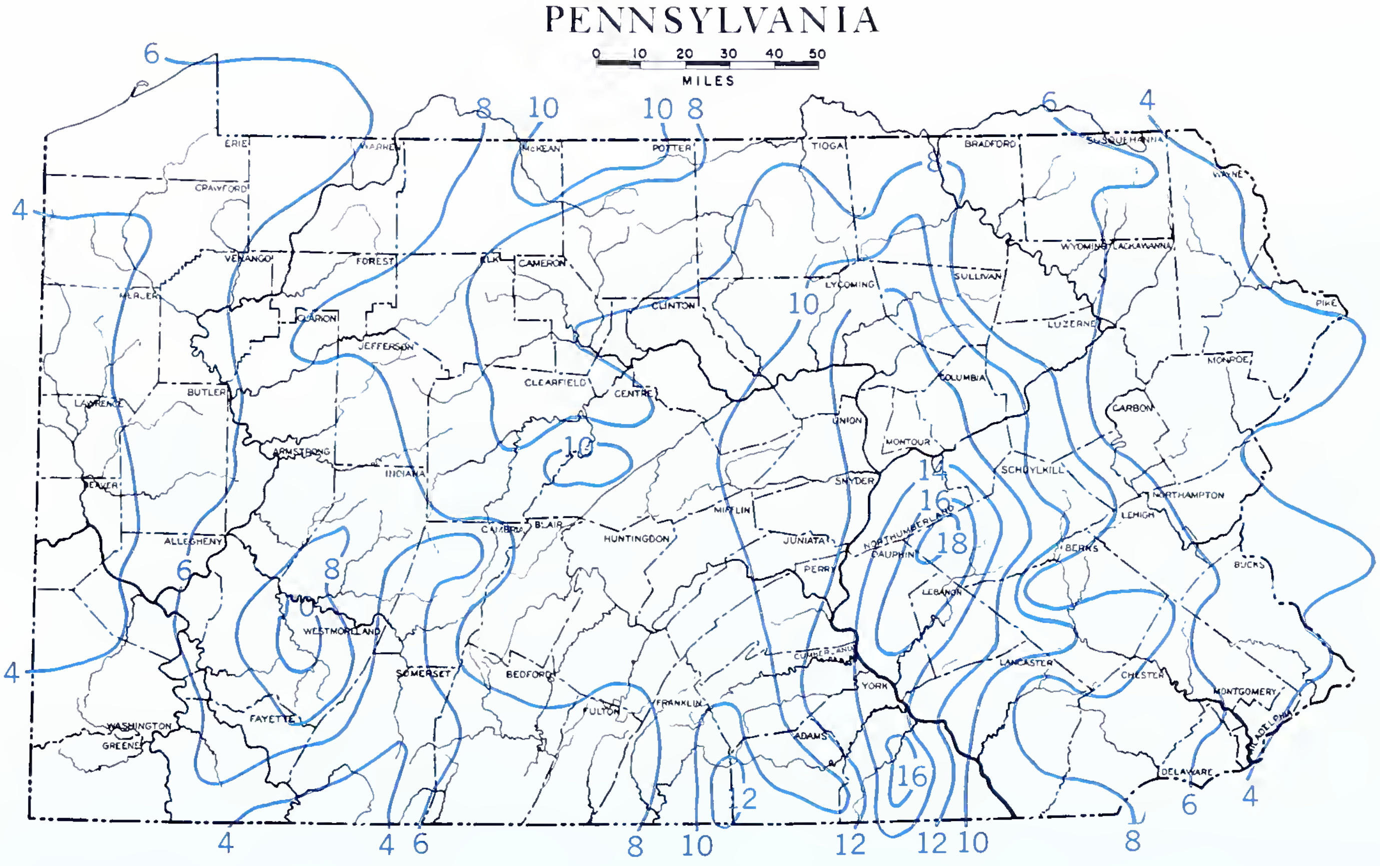


Figure 3. Total "Agnes" Rainfall - June 20 thru 25, 1972 (inches)
From P.M. on 20th or A.M. on 21st
Thru P.M. on 25th or A.M. on 26th
(Date from Dr. J.J. Rahn, NOAA State Climatologist
for Pennsylvania, University Park, Pa.)

what to do first. Entrances to rooms were blocked by jumbled furniture. No light existed to explore interior windowless rooms. There was constant danger of cuts from broken glass and possible tetanus or hepatitis infections. Other problems included: how to evaluate what to attempt to save; where to take flood-damaged but salvagable materials; what to do with non-salvagable materials.

Salvage at the Survey proceeded rapidly with maximum effort by all of the Survey staff, including geology-student summer assistants, as well as numerous friends of the Survey. Because of the superb efforts of all, most of the important Survey manuscripts and research materials were saved. The bulk of equipment, furniture, and the physical things which comprise the Geological Survey were seriously damaged or destroyed.

Individuals assumed responsibility for salvage of materials in their offices and everyone worked where help was needed. The Editorial Division received high priority and about 40 manuscripts in various stages of preparation for publication and representing literally hundreds of man-years of work were rushed to Williams and Heintz in Washington, D. C., for immediate washing and drying in a massive successful attempt at saving them.

Some of the materials from the files were taken to commercial food lockers to be frozen; weeks later they were thawed and dried individually on the floor or strung from lines in temporary quarters to which the Survey was almost immediately relocated within 3 days after salvage started. Some of the frozen files and books were stacked in hay and dried in the hay drier at Hershey Farms in Hershey, Pennsylvania. Survey people had washing and drying operations at their homes for several weeks. Many pieces of intricate scientific equipment were shipped or carried by car to parent companies for cleaning, overhaul and repair. Metal furniture and other items were steam cleaned at the new Survey quarters and gradually put back into operation. Much was left behind, too badly damaged to be saved.

The Loss

In terms of tangibles, the main loss was the Survey's library of nearly 40,000 volumes and the map library containing 250,000 maps. The volumes were awaiting new shelving at the time of the flood and became a chaotic mess in the cardboard boxes in which they were stored on the floor. The bulk of the library contents were subsequently removed by a front end loader and piled at the street curb, not a pleasant sight. This rubble contained the published work spanning not only the 138 years of nearly continuous activity by this agency, but also housed geological data from every state in the union and from a large number of foreign countries which publish geological information. Its scientific importance to the Commonwealth's community of geologists and the citizens they service is immeasurable. It is gone.

Water damage and subsequent corrosion ruined some equipment such as altimeters, typewriters, calculators and cameras, while some pieces such as the delineascope (3½" x 4" glass slide projector), which is now almost obsolete, came through virtually unscarred. Almost everything made of wood, desks, drafting tables, book cases, microscope cases and other equipment containers, was a total loss. The nature and extent of damage to our x-ray machine is still unknown.

Evaluation of intangible losses is more difficult. The loss of time and progress on research projects can only be evaluated in terms of delay of completion and delay in the start of the next project. The value of lost data may be unknown for years—until the data is needed and found missing. The loss of the library will make itself felt everytime required data or background information is unavailable.

The Present and Future

The Pennsylvania Geological Survey is now relocated on the second floor of the former Evangelical Press Building at the corner of Third and Reily Streets in Harrisburg. Drying and cleaning of equipment and files will continue for some time, but operation of the Survey is slowly returning to an approximation of normality. Much equipment needs replacement and a library must be rebuilt. As individuals complete salvage of their personal and research materials they are returning to project work and attempting to pick up where they left off on June 21, 1972. The Editorial Division is already back in limited operation and some field geologists have returned to project problems.

As often happens when people share an experience such as a flood, an 'espirit de corp' has developed in the Survey which will certainly assist the rebuilding of the organization. It is certain that as momentum is gained the Pennsylvania Geological Survey will rise to meet the geological challenges of Pennsylvania and perhaps be better and wiser because of its experience.

The Lesson

The recent floods in the Susquehanna River basin and their effects on thousands of people can only emphasize how little attention man is paying to the reality of natural events. Flooding is a natural and repetitive event which is intimately related to geologic, topographic, meteorologic and land use factors of any area. Continued disregard for these factors means continued loss and misery for those effected.

Flood hazard areas can be utilized in many ways which receive minimal effect from flooding. Such uses are parks, parking lots, athletic fields and other non-structure uses. Future utilization of areas recently flooded should be directed towards such use.

Because of its important lesson, the physical effects of the Agnes-related flood on erosion and redeposition should receive high-priority attention because of the opportunity to evaluate stream processes at a scale which occurs infrequently in one individuals life span but frequently in the longer span of geologic time. The geologists ability to interpret and predict future events, such as floods, depends largely upon how well he evaluates the recent data and the preserved past record of similar events. Perhaps his greatest responsibility is to bring home to other people that natural events such as floods will recur and that man must learn to relocate and readjust his life and his works to those events.

William D. Sevon

MOUNTAINS OF SOLID WASTE

The Pennsylvania Department of Environmental Resources reports that as of the end of August, 15,826,000 cubic yards of solid waste had been generated by the flood or resulting from flood damage. Placed in more readily understood terms, the amount of solid waste generated by the flood and subsequent recovery operations would fill nearly 200,000 railroad gondola cars, enough to stretch from Philadelphia to Los Angeles. Department records indicate that at the peak of the clean-up in the Wilkes-Barre Kingston areas, 78,000 tons of solid waste were being removed daily to sanitary landfills. To put this in perspective, it should be noted that Philadelphia, with its population of approximately 2.5 million persons, produces about 5,000 tons of solid waste a day. Thus the peak load in the Luzerne County area cited was more than 15 times as heavy as that produced in the State's largest city under normal circumstances. At one point debris was piled 10 feet high on either side of the street leading an observer to say he was driving through a "canyon of waste".

At the height of operations in the Wilkes-Barre area there were about 16 landfill sites operating during daylight hours. Most were strip mine sites, while there were also some sand and gravel pits. The fortunate thing was that the landfill sites were located close to the cities, making it possible to move in 1,000 to 2,000 truckloads a day at the larger sites. General Motors Acceptance Corp. took over a site for the crushing of some 4,000 new and used General Motors cars which had been caught on dealers lots and in showrooms in the floods. Some $3 million worth of liquor which had been stored in a warehouse affected by the flood was taken to a landfill and destroyed. Millions of dollars worth of food, drink, and pharmaceuticals were embargoed to prevent use and disposed of at sanitary landfills. Responsibility for properly disposing of the thousands of tons of waste rested with the Division of Solid Waste Management of the Department of Environmental Resources.

AGNES' LACUSTRINE LEGACY

Tropical storm Agnes left behind a legacy of death and destruction unequaled in the history of Pennsylvania. Besides washing away cars, bridges, houses, and people, the storm and and ensuing flood also caused changes in the topography and surficial geology of the state. Streams changed their courses, landslides revealed new bed rock exposures, new springs appeared, and several new lakes formed from Agnes' waters.

Two of these new lakes, one in Washingtonville Quadrangle, Montour County, and the other in White Deer Valley in Lycoming County (Montoursville South Quadrangle), were investigated by the Pennsylvania Survey. These lakes occupy natural depressions on gently dipping limestones of the Silurian Tonoloway and Keyser Formations, and have no surface outlets. They formed from surface runoff and new ground-water springs, and continued to rise for a few days after the rain stopped. Drainage from these lakes is through underground seepage beneath topographic divides, through an unseen network of fractures and solution channels in the limestone bedrock.

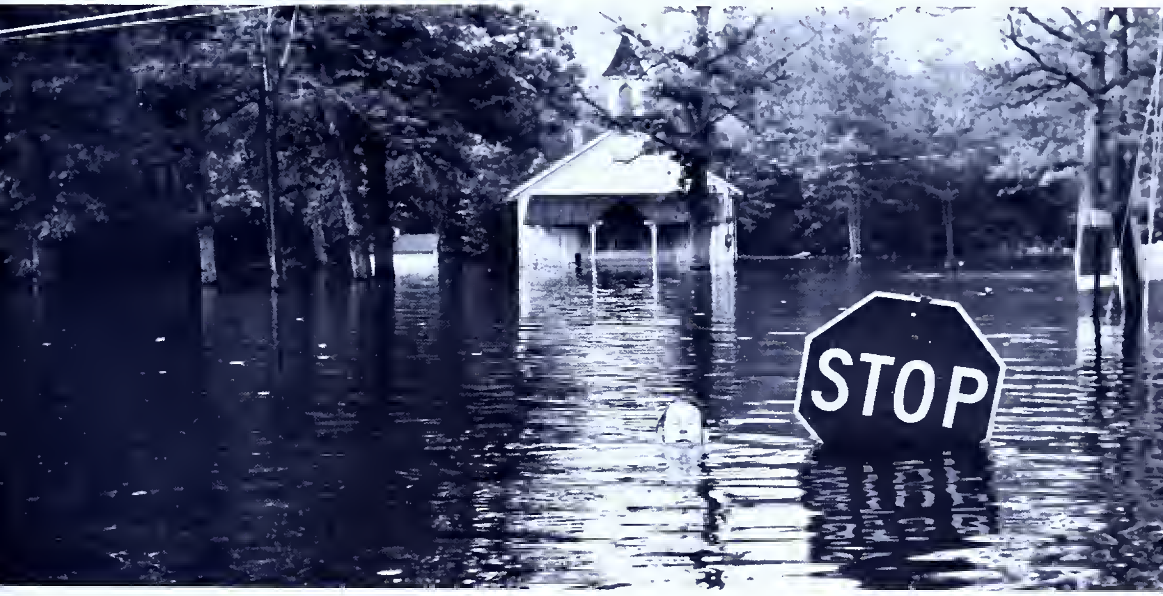
"Lake Agnes", as the new lake in Limestone Township, Montour County came to be called, covered L. R. 47020 and extended some 2,000 feet north of the road, with a maximum depth of 35 to 40 feet. This lake soon became popular with boaters and sight-seers, as water-skiers skimmed over the corn and wheat fields. One farmer, who owned part of the land under Lake Agnes, claimed that if he had been able to charge people a dollar a head to visit the lake, he would have made more money than he could by farming. Thirty days after the storm, this lake had dropped four feet, draining at a rate of 1½ inches per day.

The second lake investigated was in White Deer Valley, and inundated the community of Maple Hill in Brady Township, Lycoming County. This lake is called "Sinks Lake", from a swampy depression by that name which now lies at the bottom of the lake. It covered two state roads (L.R. 41008 and 41009) to a depth of 6½ or 7 feet, and was over 1½ miles long and 40 feet deep at its maximum. Sinks Lake was also popular with swimmers and boaters, but not so popular with the residents of White Deer Valley, who found the only road out of the east end of the valley blocked by the high water. Sinks Lake was larger than Lake Agnes, and slower to drain, dropping only 15 inches by July 22nd.

Call it the fickleness of Mother Nature, or simply the meteorological vicissitudes of the summer of '72, but the unusually wet weather of June was followed by six weeks of virtually no rainfall. By August 22nd Lake Agnes was no more, Sinks Lake had dropped below the lowest road level, and the flow of traffic was again restored in White Deer Valley. Water levels in limestone terrain are quick to reflect changes in precipitation, and if we had had normal rainfall during July and August, the road junction at Maple Hill would still be under water.

We would do well to remember that although storms like Agnes seem to be single, catastrophic events, they are a normal part of the long-term history of the area. Even though this may have been a "hundred-year flood", which occurs on an average of once each century, the water has been this high in the past and will rise again. Meaningful averages of relatively rare occurrences such as this are difficult to calculate, and such figures become totally irrelevant when the water is cresting over the dikes and the rain is falling for the fifth or sixth straight day. Rather than consider the Great Flood of '72 a thing of the past, over and done with, it might be wiser to plan for the next Great Flood by raising some of our roads, intersections, and other critical facilities above the flood plains.

Richard B. Wells



Sinks Lake

Lake Agnes

SURVEY ANNOUNCEMENTS

The Bureau of Publications, which stores the stocks of Pennsylvania Geological Survey publications, was flooded during the recent Susquehanna River rampage. Large losses were incurred to all Survey publications and some stocks were almost entirely destroyed. Many of these publications will be reprinted as soon as time and money permit. Such reprinting will be announced in this magazine.

All stocks of Pennsylvania Field Geologists Conference guidebooks were destroyed by the flood. These guidebooks will also be reprinted as soon as time and money permit.

NEW SURVEY PUBLICATIONS

Publication	*Title*	*Cost*
M63	**Properties and Uses of Pennsylvania Shales and Clays, Southeastern Pennsylvania,** by Karl V. Hoover, Timothy E. Saylor, Davis M. Lapham, Miles E. Tyrell. (329 p., 17 figs., 8 tables)	$4.95
IC72	**Coal Reserves of Pennsylvania: Total, Recoverable, and Strippable (January 1, 1970),** by William E. Edmunds. (40 p., 6 figs., 7 tables, 4 appendices).	.85
W20 (2nd Ed.)	**The Ground-Water Observation-Well Program in Pennsylvania,** by Charles W. Poth. (18 p., 8 figs., 1 table).	.40

STRATIGRAPHIC FRAMEWORK OF GREATER PITTSBURGH AREA— PART 2, ON OPEN FILE

The Bureau of Topographic and Geologic Survey in cooperation with the U. S. Geological Survey began an environmental study of the Pittsburgh area by preparing a stratigraphic framework of the surface and near surface rocks. This information on the nature and distribution of the rocks is needed for succeeding phases of the total environmental study and these data in the form of cross sections are a valuable guide to anyone engaged in excavation, construction, mining and drilling in the area.

Part 1 consisting of four cross sections through Allegheny, Washington, Beaver, and southern Butler Counties, a short text, and several figures was placed on open file in October 1971.

Part 2 has now been completed and is on open file at three locations: Bureau of Topographic and Geologic Survey, 401 Pittsburgh State Office Building, 300 Liberty Avenue, Pittsburgh; U. S. Geological Survey, 102 East Mall (Second Floor), Carnegie; and the Bureau of Topographic and Geologic Survey, 3rd and Reily Streets, Harrisburg.

This report includes four cross sections through Westmoreland, Armstrong, northern Butler, and western Indiana Countries, 20 pages of text, several figures, and one table.

All interested persons are encouraged to examine this report at the offices cited. Copies of the report may be made available at the expense of the individual.

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In Cooperation with The U.S. Geological Survey

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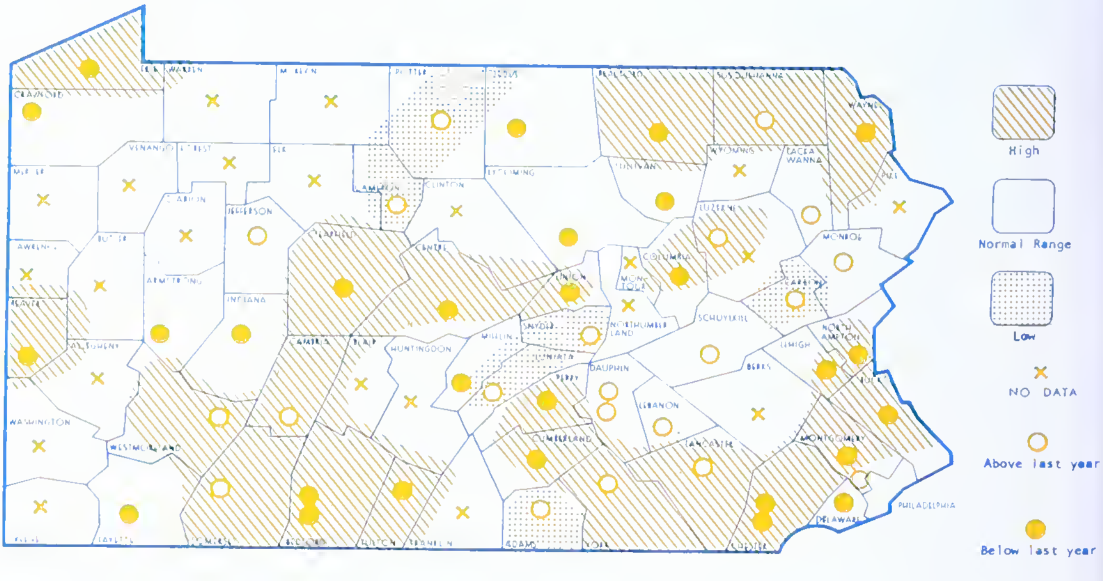

PENNSYLVANIA GEOLOGY

THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 2/6

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

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ON THE COVER – a panoramic view of the East End Open Pit at Cornwall, Pennsylvania. This is the last operating mining unit at Cornwall. After 200 years of continuous operation, the Cornwall mines will shortly be closed down. Old miners village appears in background. *Photo courtesy Bethlehem Mines Corporation*

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

OCTOBER 1972

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

OUR LIBRARY NEEDS

The library of the Pennsylvania Geological Survey, as many of you are aware, was 99.9% destroyed in the flood of June 21 - 24, 1972. We are now in the process of rebuilding. While the library was originally designed as a research reference library primarily for the professional staff of the Survey, over the past few decades it has also functioned as a public library open to anyone needing geological information on Pennsylvania and the United States.

We intend to rebuild our library to be one of the best available geological research libraries with emphasis on the geology of Pennsylvania and the immediately surrounding states. To this end, we will attempt to obtain all known publications on the geology of Pennsylvania. We also intend to obtain complete runs of the publications issued by the State Geological Surveys that border on Pennsylvania. We will also regain complete runs of the major geological periodicals and the publications of the United States Geological Survey. We plan also to house selected publications, primarily of a topical nature, of other states and foreign countries. For general reference, we will obtain a broad range of representative and up to date textbooks of all of the major sub-disciplines of geology.

Many of the early publications will be difficult to obtain. For these we will from time to time issue requests for assistance in finding certain publications. Following is a beginning list of some of our older publications needs.

1. Geological Map of Pennsylvania, 1858 by H. D. Rodgers issued with the 2 (two) volumes set of "The Geology of Pennsylvania, a government Survey" in a slip case bound similar to text volumes.
2. Geological Map of Pennsylvania, issued with Atlas Final Summary Report of the Second Pennsylvania Geological Survey, 1855.
3. Geologic Map of Pennsylvania, 1931 by Stose and Lungstedt.
4. Transactions of the Geological Society of Pennsylvania, 2 (two) volumes issued in 1835.
5. Grand Atlases of the Second Pennsylvania Geological Survey bound in 6 (six) large black portfolios.
6. Miscellaneous Papers Nos. 1 - 6 of the Fourth Geological Survey, all by G. H. Ashley.
    a. The Story of the Survey, 1920.
    b. The Work of the Survey, 1923.
    c. Administrative Report, 1931.
    d. The Resources of Pennsylvania in a Nutshell, 1931.
    e. Fifteen Years, September 1, 1919 to September 1, 1934.
    f. A Quarter Century of Progress.

Arthur A. Socolow

CORNWALL: THE END OF AN ERA

Introduction

All of us knew that the ore at Cornwall would one day be exhausted. The end was in sight, but Hurricane Agnes accelerated the process. Loss of power during the hurricane caused the water pumps to shut down. The mines rapidly began filling up with water, submerging pumps in the process. By the time power was returned, it was too late. Dewatering to mine the remaining underground magnetite iron ore would have been too costly to continue. Thus, the eastern and western mines were closed. Only the small east-end open pit remains and its life span is short, considerably less than a year. Then the ground water will move in inexorably, finally, to fill the open pits and submerge this unusual historic, economic, and mineralogic deposit. We shall witness the end of a long and fascinating chapter in the history of our state and nation.

History

The beginning of operations at Cornwall in Lebanon County, Pennsylvania are shrouded in the past of America's early history, - indeed in its pre-Revolutionary War decades. It is known that Peter Grubb began prospecting in the 1730's in what now is northern Lancaster County. His father had come to America in 1679 and settled along Brandywine Creek ("Grubbs Landing") to become a "native" Pennsylvanian. Peter discovered ore at the present site of Cornwall outcropping on three hills, Big Hill, Middle Hill, and Grassy Hill. In 1734, he purchased 300 acres from William Allen for 135 pounds, an acreage originally owned by the three sons of William Penn. Four years later he purchased an additional 142.5 acres and built the Hopewell forges on Hammer Creek six miles south of the ore deposits. In 1742, Peter Grubb built a charcoal furnace at Cornwall and named it "Cornwall Furnace" after the English mining county where his father was born. This date, 1742, is the usually accepted date for the beginning of mining at Cornwall, — 230 years ago.

From 1742 to the present there have been many owners and the mines have participated in a large share of this nation's critical history. For example, in 1777 Hessian prisoners were pressed into service at $0.60 per day to make shot, shells, and cannon for the Continental Army. In every succeeding war, and more importantly for the industrial uses of iron and steel, the magnetite iron ore of Cornwall has played a significant role. History also is recorded by photographs of black slaves toiling in the open pit in pre-Civil War days, by mule and horse-drawn ore carts, by early steam-driven percussion drills, narrow-gauge rail haulage, and a myriad of other mementos of our changing past.

In 1786 Robert Coleman from Ireland became a part owner with Peter Grubb the Third. In 1856 the Cornwall Furnace was rebuilt and can be seen today in restored condition as a Museum operated by the Commonwealth of Pennsylvania. In 1883, the last cast was made from this furnace built by Peter

Grubb. From a multitude of ownerships such as the Robesonia Iron Co., The Pennsylvania Steel Co., and The Cornwall Ore Bank Co., Bethlehem Steel Corp. began acquiring ownership, completed in 1926. With a concentrator at Lebanon later replaced by a pelletizing plant at Cornwall, two major underground ore bodies, the large open pit, and several smaller open pits, the Cornwall ores have been in continuous production for 230 years and have provided work and yielded products that have contributed mightily to the development of both state and nation. Not only the economic history but also our architectural history at Burd-Coleman and Miners villages is well represented by Cornwall. It is a landmark of the past whose importance continued its growth to the present time.

Economic and Geologic Importance

Ore production of magnetite was all from open pit mining through 1900, by which time more than 18 million natural net tons had been processed. In 1921 a three-compartment shaft was sunk beneath the open pit and in 1927 development was begun of an eastern ore body that had been discovered in 1919 by geophysical exploration. All three major ore bodies continued in production until the closing of the open pit in 1953. In later years, the eastern mine was the major producer. Production will close with an open-pit operation at the east end of the original open pit. Total production since 1742 probably will exceed 100 million tons of iron ore.

In addition to iron ore from magnetite, Cornwall has yielded many valuable by-products. Among the most notable have been copper from chalcopyrite (native copper was found near the surface in the early days of mining), cobalt from pyrite, gold and silver from chalcopyrite, and sulfur from the sulfides. Waste rock, particularly host limestone, has been used for road aggregate and fill. It is interesting to note that the cobalt from Cornwall has represented the only U.S. cobalt production east of the Mississippi River. As much as 1700 ounces of gold have been produced in one year at Cornwall. The iron ore grade averaged 40 - 42 per cent iron before pelletization. Copper in the copper sulfide concentrates generally ranged between 25 and 30 per cent copper. Cobalt averaged more than 1.0% in the pyrite concentrates. The fact that the ores were essentially lacking in phosphorous and titanium has also been of benefit to mining here.

The ores were first investigated geologically in 1858 by the Pennsylvania Survey's first State Geologist, Henry Rogers, followed by studies by other Survey geologists, including Lesley and d'Invilliers, Spencer, Hickok, Gray, Lapham, and many others. The deposit has attracted geologists for over 100 years because it is very nearly unique outside of Pennsylvania: magnetite associated with diabase. Spencer coined the term "ore deposits of the Cornwall type" to represent them and Lindgren in his famous classification used this deposit as representative of his "pyrometasomatic" ore deposits. Much of the recent work has been done by the Pennsylvania Geological Survey and a publication on Cornwall by Lapham and Gray is in press. Theories of origin have ranged from remobilized sedimentary iron through many ingenuous magmatic explanations. The latter are generally accepted today, the principal discussion being whether the magnetite originated directly from the underlying diabase, as Spencer and Lindgren believed, or from an underlying magmatic source which also had been the source of the diabase. The Survey currently favors this latter explanation. Whichever ultimately becomes accepted, Cornwall certainly has exerted a fascination for geologists, and it probably will continue to do so.

Mineral Collecting

It has been almost literally an era in the geological sense that Cornwall, Pennsylvania has been a Mecca for mineral collectors from all over North America. Whether Peter Grubb was the first mineral collector in 1742 we shall probably never know, but certainly it was his curisosity and mineral knowledge that brought Cornwall into being. Since that time, many thousands, perhaps hundreds of thousands, of collectors have poured over the famous dumps, searched the open pits, and even entered the farthest recesses of the underground mines in their unremitting hunt for unusual and fine mineral specimens among the nearly 100 species known from there. And they have been amply rewarded as fine collections throughout the world can attest. Now, all this too is at an end.

Because of the premature closing of the underground operations resulting from Agnes, freshly dumped material is no longer available to mineral collectors. Although this may seem a near disaster to amateur and professional mineralogists, we all are in the debt of Bethlehem Steel Corporation for their wonderfully cooperative policy in allowing us enthusiasts to collect there. Few companies in the history of mining have been so gracious. We owe them a vote of sincere thanks.

In the meantime, preserve your Cornwall specimens with care. Make sure they are well labeled. If you have extra specimens contact the Pennsylvania Geological Survey or a museum such as the William Penn Memorial Museum in Harrisburg. Good Cornwall specimens should be where they will benefit the largest number of people and a museum is an excellent final resting place for the remarkable and beautiful minerals that Cornwall has produced.

Acknowledgements

The Pennsylvania Geological Survey is grateful to many staff members of Bethlehem Steel Corporation for supplying information on Cornwall and for permitting its release. We particularly wish to acknowledge Dr. Gilbert Hole, Chief Geologist, and Messrs. Biemesderfer, Olsen, Shale, Sims, and Peets for their assistance and for some of the accompanying photographs.

General References

Gray, Carlyle and Lapham, D. M. (1961), Guide to the geology of Cornwall, Pa. Geol. Survey 4th Ser. Bull. G-35.

Lapham, D. M. and Geyer, A. R. (1969), Mineral Collecting in Pennsylvania, Pa. Geol. Survey 4th Ser., Bull. G-33, 3rd edition.

INTERESTING FACTS ABOUT THE CORNWALL MINES

Prospecting in the area began about 1730 on a tract of land granted by William Penn "for as long as grass grows and water runs:" Magnetite ore was discovered in 1732 by Peter Grubb on three hills in the area.

In 1737 the Hopewell forges were built on Hammer Creek to smelt the ore and in 1742 Peter Grubb built the first Cornwall Furnace, re-built in 1856. Mining activity continued from 1742 to 1972 and Cornwall thus has become the longest continually operated mine in North America: 230 years.

In 1777 Hessian prisoners labored for $0.60 per day to provide cannon and shot for the Continental Army.

By 1864 there were 96 separate partial ownerships of the mining area and 6 furnaces. In 1926, Bethlehem Steel Corp. became the sole owner of the mines, ending more than 50 years of competition and litigation over the ores.

More than 100 million tons of iron ore have been removed and the by-products have included gold, silver, and cobalt. For the latter element, Cornwall has been the nation's major producer east of the Mississippi River.

Cornwall, Pa., named for the lead-zinc district of Cornwall, England, preserves some of the nation's best examples of 19th Century stone houses in Miners Village and Burd-Coleman Village, many modeled after their English counterparts.

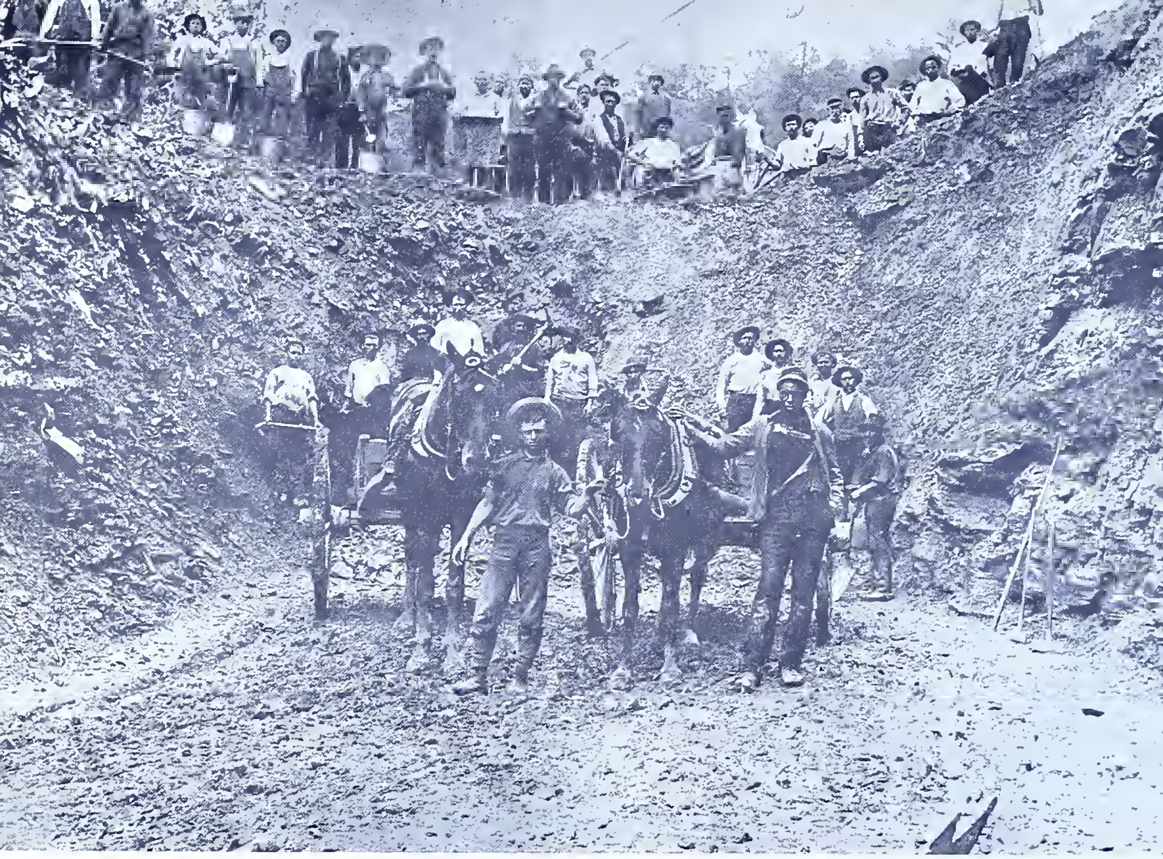
Minerals obtained from Cornwall grace some of the best mineral collections in the world. At least 95 different minerals are known to occur here.

Many innovations in mining technology were first introduced at Cornwall, including the modified bell system. Mining and exploration reached a depth below the surface of 1225' in the eastern mine.

The Cornwall deposit is representative of a group of Pennsylvania magnetite ore deposits that are unique in origin throughout the world. Thus, Waldemar Lindgren, the famous classifier of ore deposits, used Cornwall to illustrate a type of magmatic-related ores. Beginning with the classic 1908 study by A. C. Spencer, Cornwall has been a Mecca for geologists from all over the world.

During a very minor earthquake in the mid-1960's surficial mud and vegetation entered the underground workings with such force that steel rails were curled up like springs and haulage carts were smashed. The final disaster, though, was hurricane Agnes which allowed the water table to take over man's temporary domain.

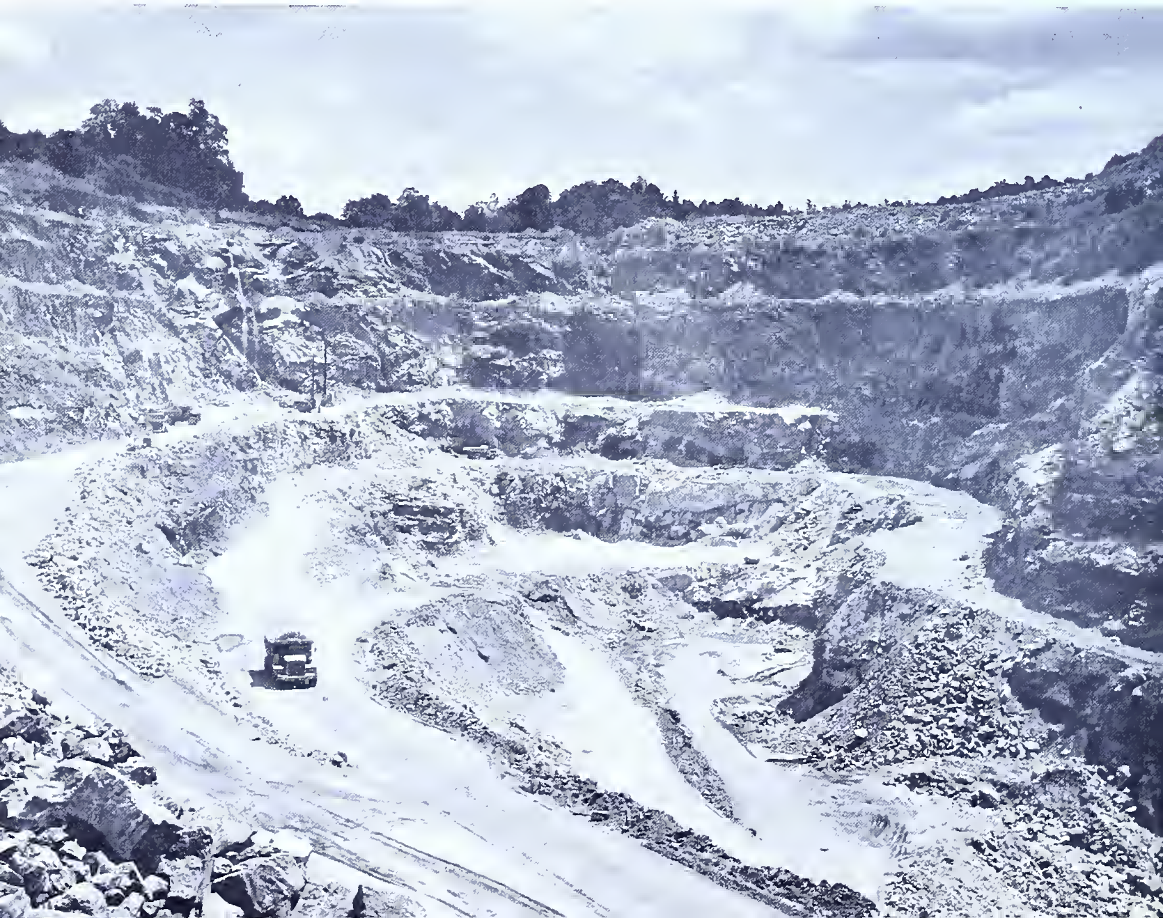
D. M. Lapham

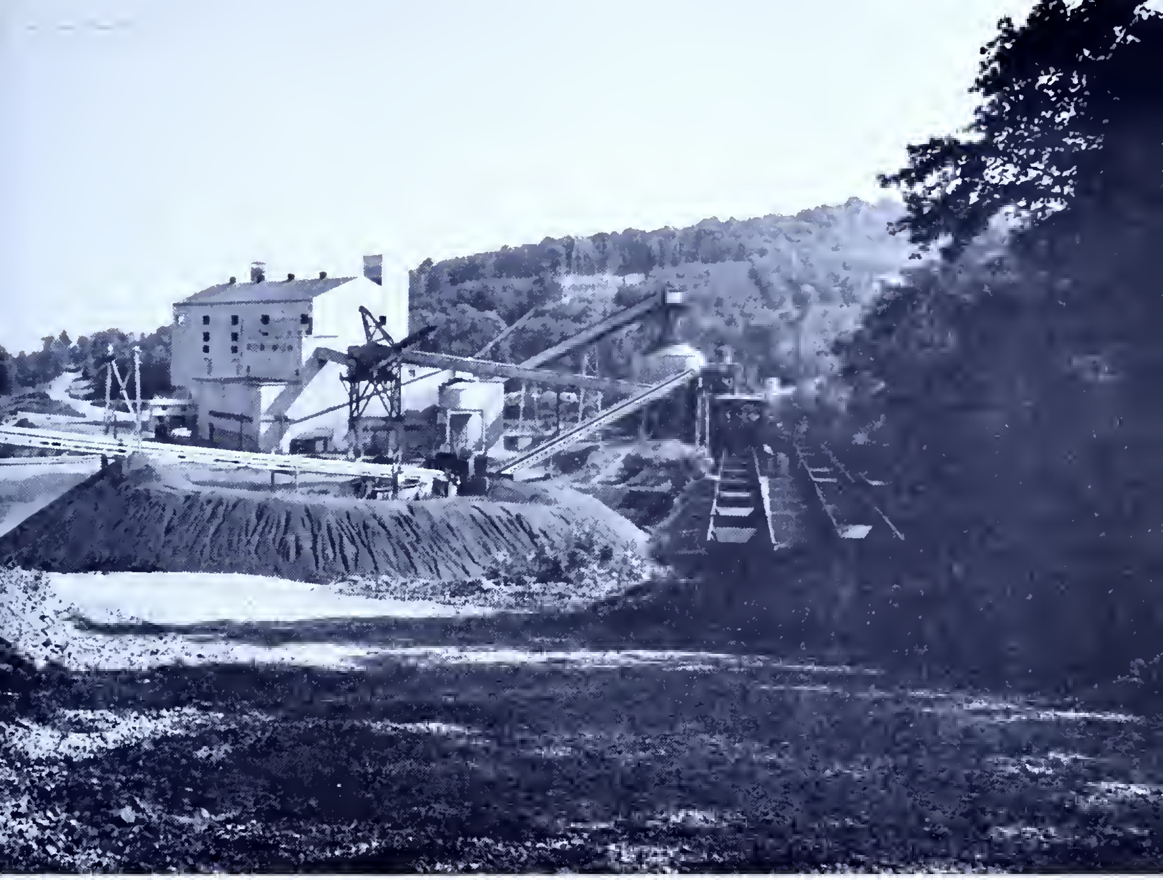


In the Beginning - earliest recorded photo, about 1800, of Cornwall open-pit mine. Equipment and haulage vehicles were simple in those days. Labor costs were held down with use of slaves.

Photos courtesy Bethlehem Mines Corporation

View of the new East End open pit mine; still in operation but not for long.

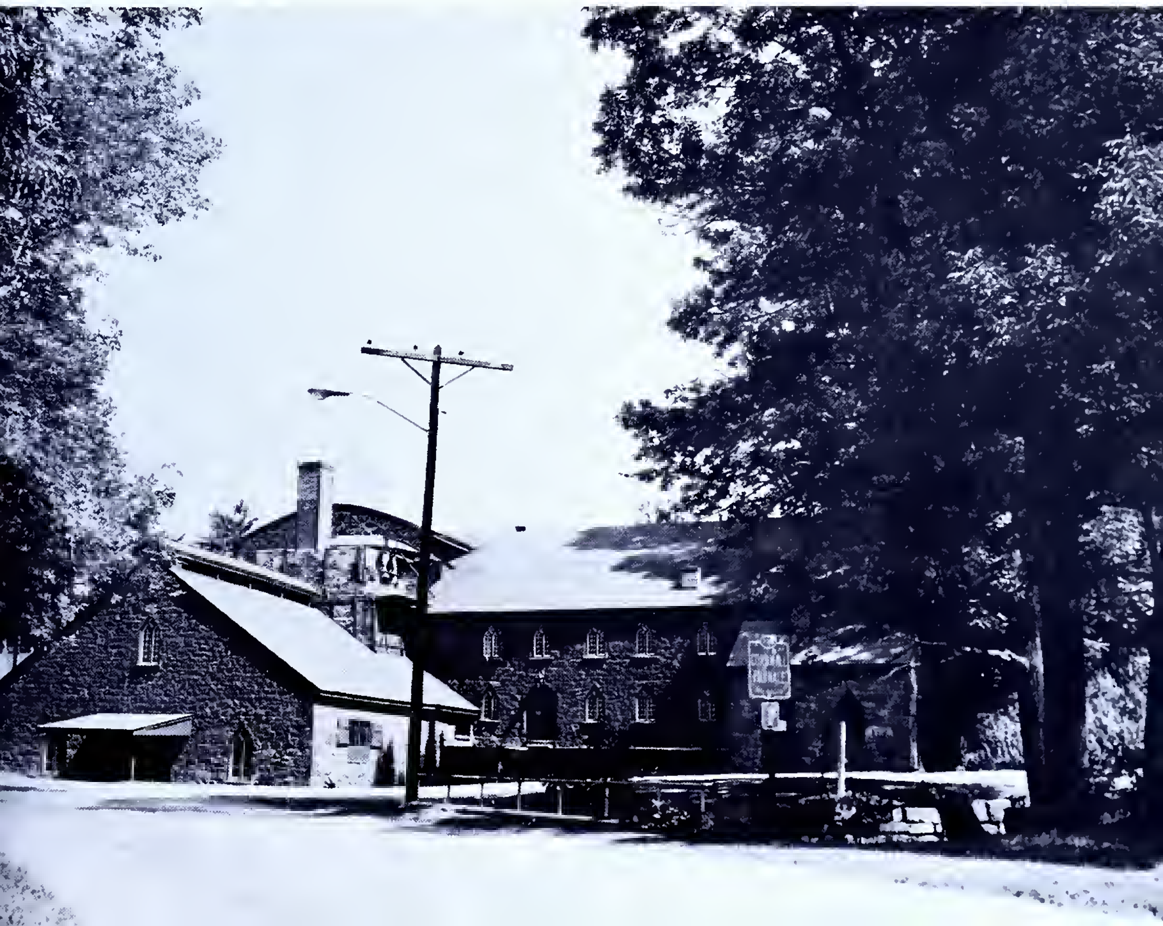


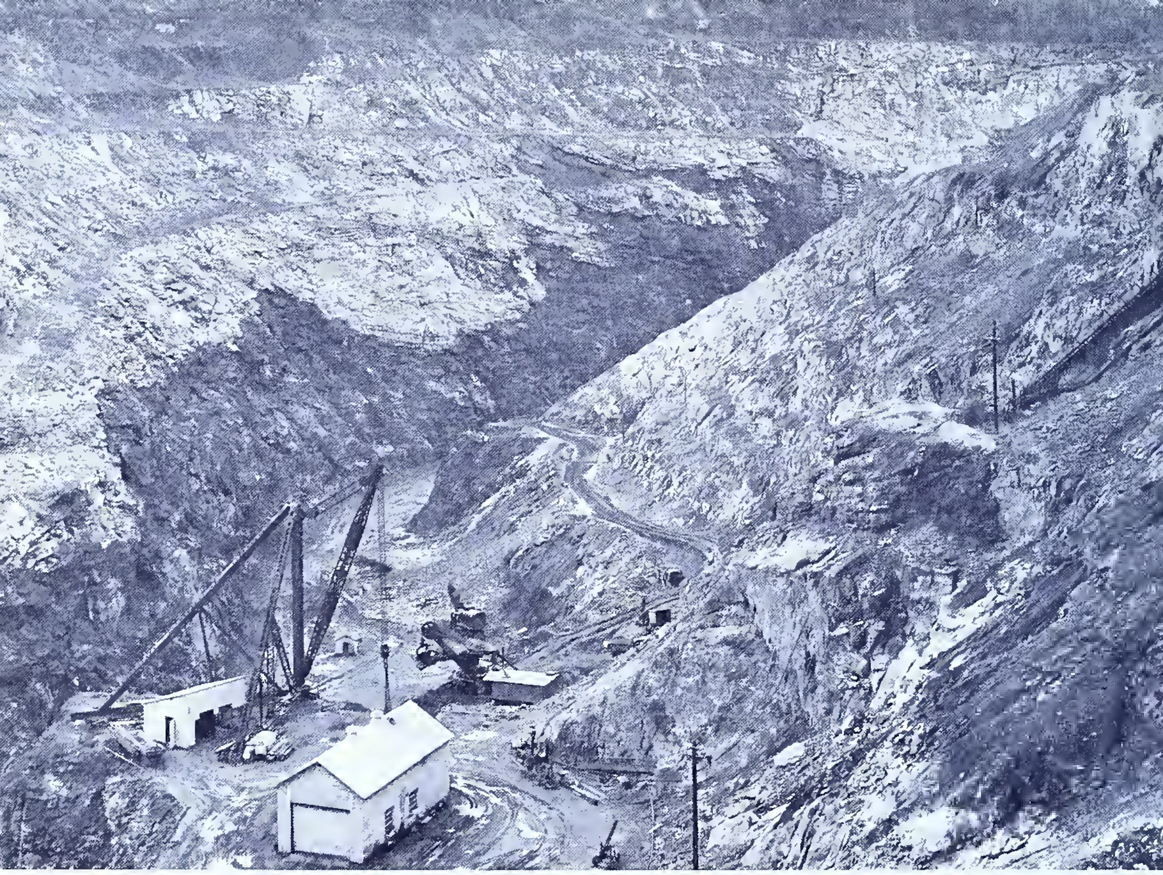


Cornwall concentrator and pelletizing plant, preparing ore for direct furnace feed.

Photos courtesy Bethlehem Mines Corporation

Cornwall Furnace, rebuilt and now maintained as a public museum by Pennsylvania Historical and Museum Commission.

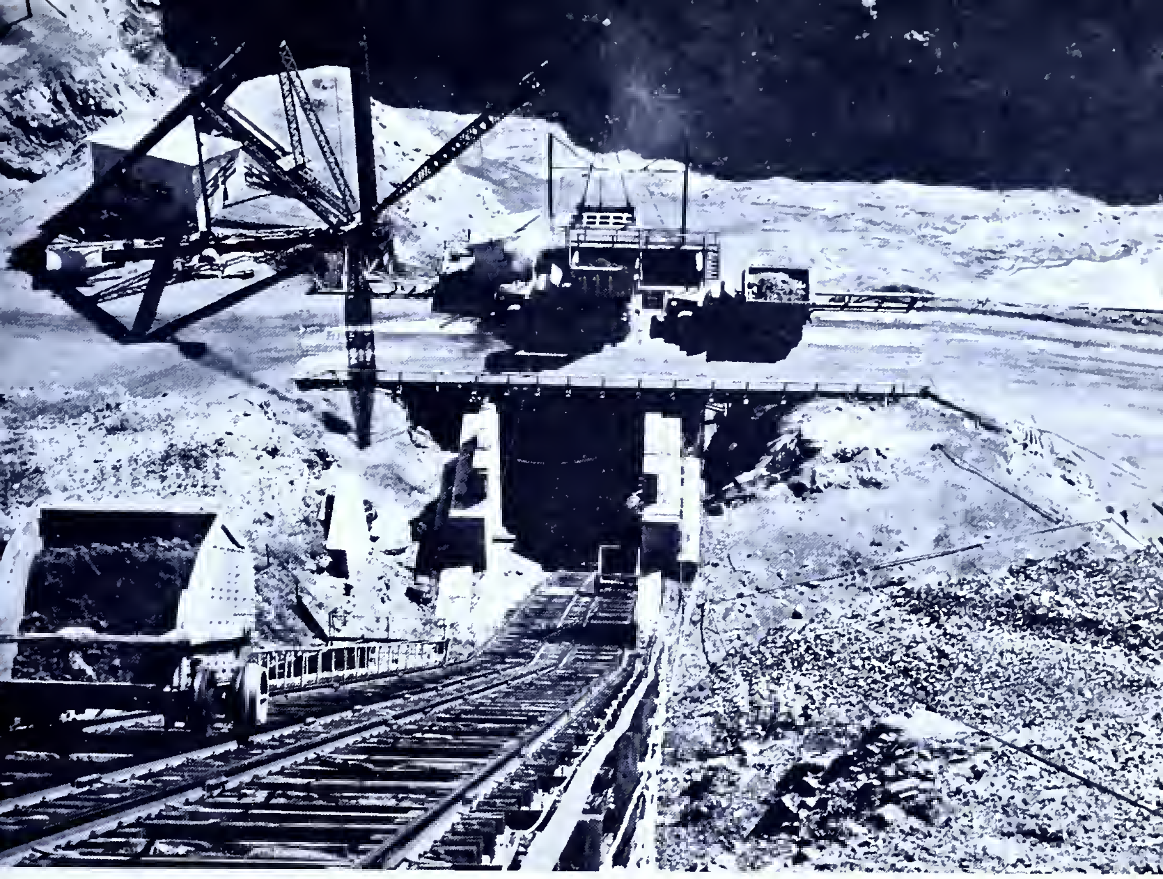




View of main open pit mine, 1952. Ore shows as black zone at base of left wall, with light-colored overlying limestone. Right wall of pit is south-dipping diabase.

Photos courtesy Bethlehem Mines Corporation

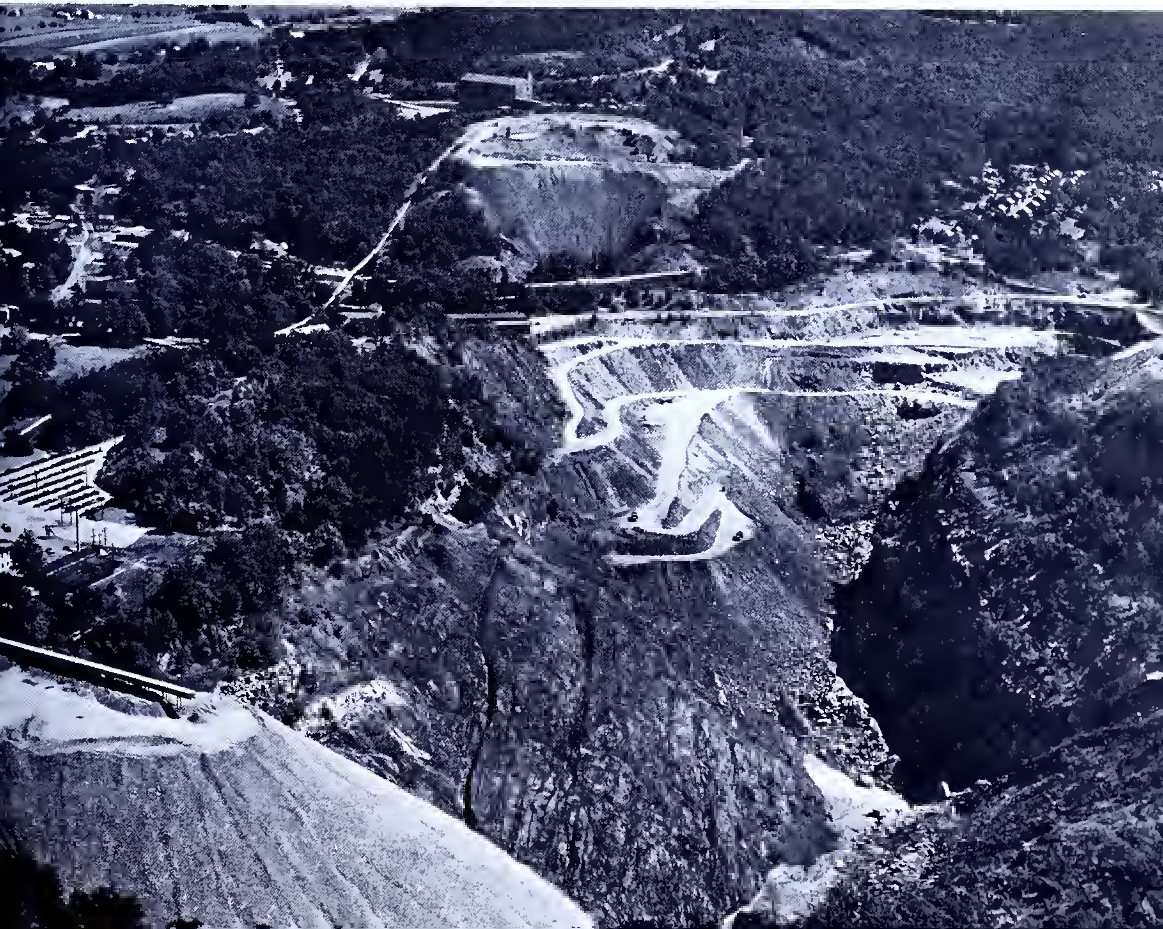
Heavy equipment in the main open pit, 1953.



Skip bringing up ore on inclined shaft of No. 3 mine, 1952.

Photos courtesy Bethlehem Mines Corporation

Panoramic view of Cornwall mines, looking east, 1969. No. 3 mine in left foreground, open pit at center, No. 4 mine in background.



DOUGHTY MINE, SUNBURY, PA.

Not all of our summer geology assistants spent all of their time cleaning up from the flood, just most of them, most of the time. Taking advantage of the mineral collecting talents of Barrett Borry, now a geology graduate student at Lehigh University, and the cave-mapping and photography experience of Marc Silverman, a senior geology major at LaSalle, the Doughty Mine near Sunbury was mapped and sampled in the middle of August. After four unsuccessful attempts to locate the mine prior to joining the staff, the author and his wife located the mine in early August after obtaining approximate directions from Dr. Allen V. Heyl of the U. S. Geological Survey. Located over a hundred feet up a cliff, the mine entrance was found after walking 10,000 feet of traverses along the hillside. On the previous four trips, a total of an additional 25 miles of traverses were made.

Unwilling to have his wife enter the mine at the same time and unable to use a tape and Brunton compass effectively with the one hand Agnes hadn't put temporarily out of commission, the author ventured through only the first 170 feet of mine workings. At this point a 20 x 5 x 10 foot deep hole in the mine floor was encountered.

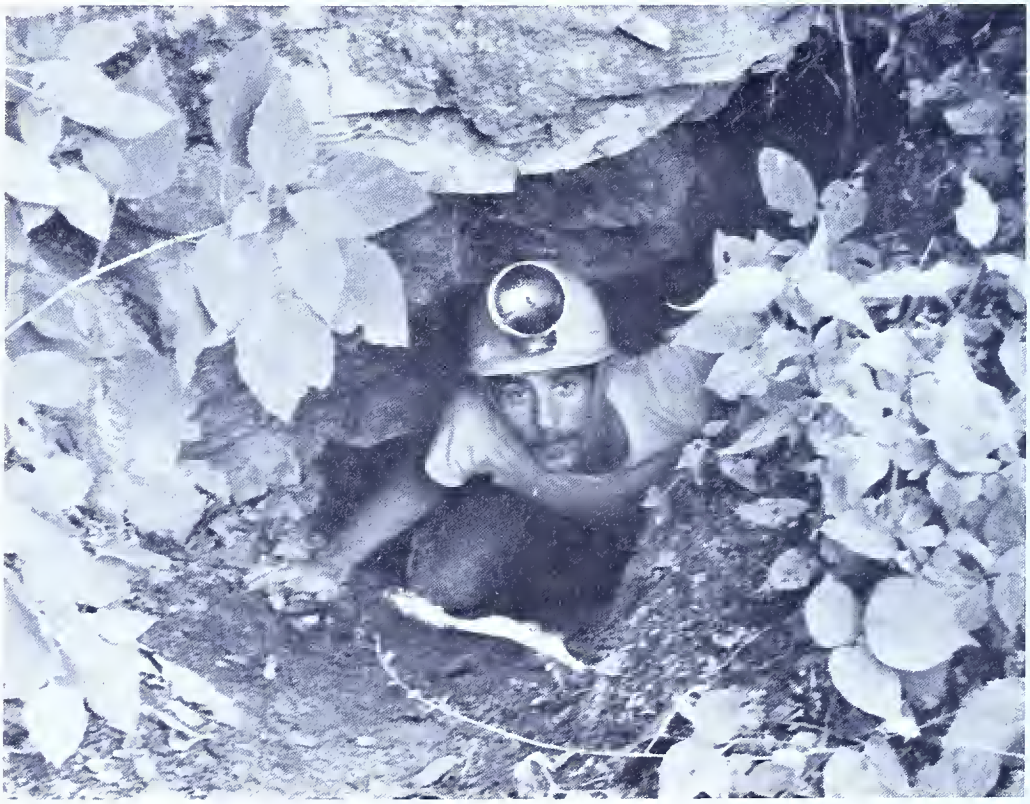


Figure 1. Marc Silverman, experienced in caving (caver) with the National Geographic Society in Puerto Rico, emerges from the Doughty Mine.

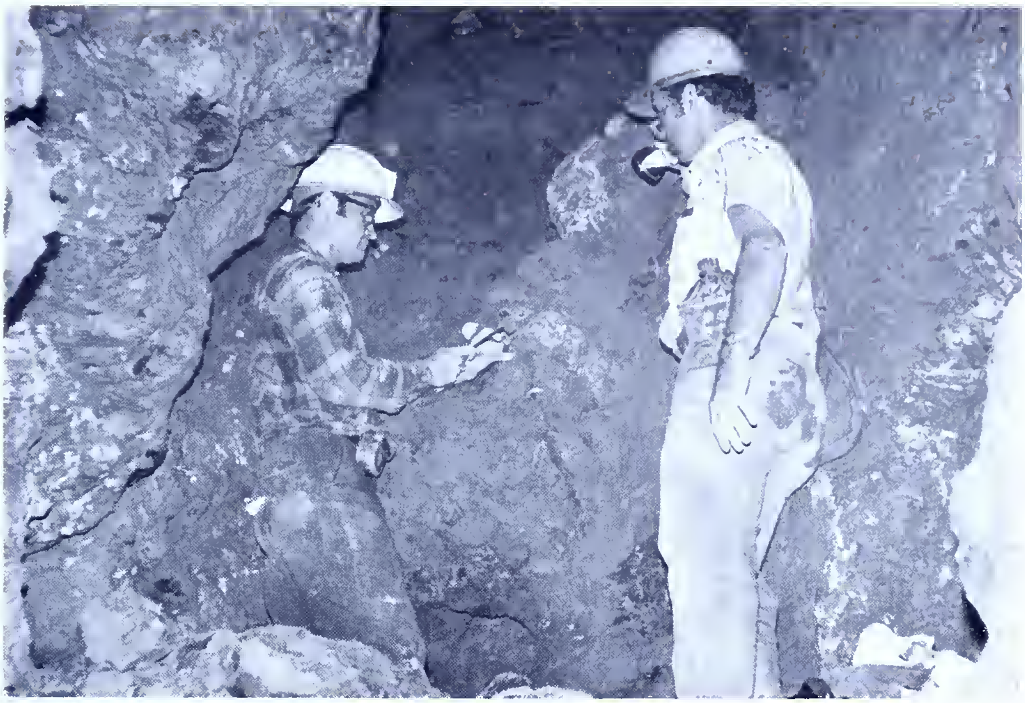


Figure 2. Bob Smith (left) and Barrett Borry (right) sample a hemimorphite - galena vein in the lower level of the mine.

Returning a few weeks later with Messrs Borry and Silverman, the author anticipated that an additional 30 feet of workings might be found, bringing the estimated total to be mapped to 200 feet. After three hours of systematic searching, the total length of possible workings was increased to slightly over 850 feet! In the process, three areas of lead-zinc mineralization were found. One of these was only a 4 inch wide calcite vein with minor galena and hemimorphite, but the other two are a 1 - 2 feet thick vein and a possible replacement bed, both with considerable hemimorphite.

Without the benefit of X-ray diffraction or even a binocular microscope, identifications are uncertain but it appears that galena, hemimorphite (earthy and crystalline), cerussite, anglestie, hydrozincite, calcite, and dolomite are present in the mine. Unfortunately, as the mine has only one entrance (less than 2 x 2 feet in size) and portions of the outcrop and mine roof are caving in, the mine must be considered unsafe for mineral collectors.

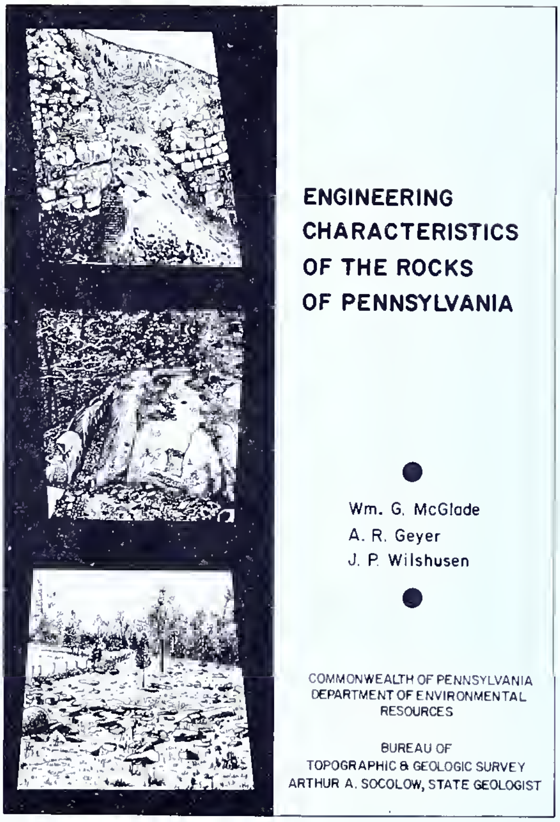
As the main haulage drift now shows traces of former wooden ties, it must be assumed that the mine once had another, more accessible, entrance which is now caved in.

Samples of pure galena from this ore (and all other galena and sphalerite occurences in the state) will be analyzed for certain trace elements in an attempt to determine if this strata (Keyser-Tonoloway Formation) has potential for economic concentrations of zinc, lead, and silver in Pennsylvania.

Bob C. Smith II

NEW GEOLOGY HANDBOOK FOR PLANNERS AND ENGINEERS

Is the bedrock suitable for building heavy structures? What type of construction materials are available from this rock unit? I would like to excavate a large area for a shopping center, how difficult is it to remove bedrock? A new highway is planned, what is the slope stability of the rocks in the area? These and many similar questions may be answered by a new publication just released by the Bureau of Topographic and Geologic Survey, the first publication of its type in the country.



ENGINEERING CHARACTERISTICS OF THE ROCKS OF PENNSYLVANIA

●

Wm. G. McGlade
A. R. Geyer
J. P. Wilshusen

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

BUREAU OF
TOPOGRAPHIC & GEOLOGIC SURVEY
ARTHUR A. SOCOLOW, STATE GEOLOGIST

"Engineering characteristics of the rocks of Pennsylvania," Environmental Geology Report No. 1, outlines important engineering, hydrologic, and basic geologic characteristics of rock formations in Pennsylvania. Summarized information is presented in tabular form for each rock unit as described on the State Geologic Map. One of the unique features of this book is the use of over a hundred photos and sketches to visually illustrate the character of each rock unit. This manual is designed to aid in initial investigations of proposed projects. It is broad in scope and will serve as a basis for regional and local land-use planning. EG 1 will provide a ready reference to the overall geometry, engineering behavior, and a visual impression of each rock formation described.

Geology has an important role to play in improving and protecting our environment. Geologic information such as presented in this publication will assist in defining the most effective use of our land and mineral resources. The Bureau of Topographic and Geologic Survey, through emphasis on the relevance of its geologic investigations to the needs of Pennsylvania, is pleased to make this contribution to better environmental planning and development.

Environmental Geology Report No. 1 may be obtained by writing to the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, 17125. The cost per copy is $2.50, plus 6% state sales tax.

SURVEY ANNOUNCEMENTS

OIL AND GAS PIPELINE MAPS ON OPEN FILE

The principal crude oil and product pipelines map of Pennsylvania and the principal natural gas pipelines map of Pennsylvania have been brought up to date as of April, 1972. Natural gas distribution lines have been added in some areas where there are no transmission lines. The locations of the natural gas storage fields are also shown.

These two maps are on open file at the following office:

Pennsylvania Geological Survey
401 Pittsburgh State Office Building
300 Liberty Avenue
Pittsburgh, Pennsylvania 15222

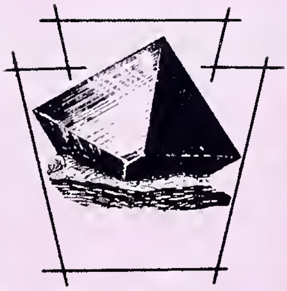
The maps are available for examination at the above office and copies will be made available at the expense of the individual.

NEW OIL AND GAS BASE MAP

A new oil and gas base map, number 36, is now available. The map (scale 1:62,500) takes in the Conrad, Coudersport, Emporium, and Genesee fifteen minute quadrangles covering parts of Cameron, McKean and Potter counties. Paper prints of this map, which shows the locations of all oil and gas wells with records (includes all wells drilled since 1956) in this office with gross field limits, can be obtained by writing to Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Cost of each map is $0.50 plus 6 percent state sales tax. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering, please specify the map number.

IF YOU ARE INCLINED TO DO SOMETHING BAD,
ARE YOU SYNCLINED?

Terry Wilson



EARTH SCIENCE TEACHERS' CORNER

new pennsylvania earth & space science teachers guide

A new "Pennsylvania Earth and Space Science Teachers Guide", by the Department of Education, is soon to be released. This book, now in page proof, is to go to press this month, and should be available to teachers before the Christmas holidays.

The new approach to the teaching of Earth and Space Science stresses the philosophy that this is a course for all students. The Bureau of General and Academic Education feels strongly that Earth and Space Science is a course that is of great value to students of all abilities. A stimulation of interest and the ability to relate to the student are placed high on the list of objectives for the guide and the course.

NEW TOPOGRAPHIC MAP OF THE GREATER PITTSBURGH REGION

The Topographic Branch of the U. S. Geologic Survey has recently announced the release of a new topographic map - "The Greater Pittsburgh Region: Counties of Allegheny, Armstrong, Beaver, Butler, Washington and Westmoreland". This full-color topographic map, published at a scale of 1:125,000 with a contour interval of 100 feet, is available with or without the green woodland overprint.

This map is extremely accurate. It represents a series conversion with 7½ minute quadrangle control. It has been completely rescribed and all names adjusted to their proper size. Political boundaries are emphasized by an orange tint. State and county parks, highways by class and type, landmark buildings, airfields, government reservations, cemetaries, lakes, all waterways, dams, locks, flood control and water supply reservoires are identified by name.

Published as part of the U. S. Geologic Survey's Greater Pittsburgh Regional Studies program, the map is designed to serve as a basis for future projects and for regional and local land-use planning.

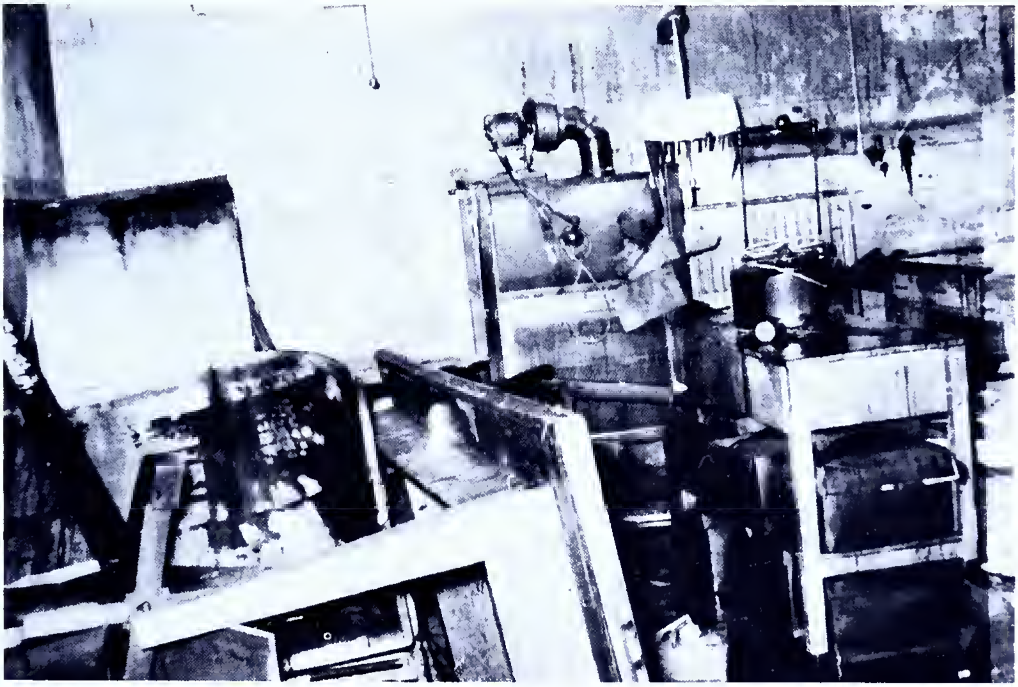
The "Greater Pittsburgh Region" topographic map is available from the Distribution Section, U. S. Geologic Survey, 1200 South Eads Street, Arlington, Virginia 22202. The cost per copy is $1.75.

AFTERMATH

Here is the sad account of a laboratory technician's dilemma during the calamity in the immediate days after inundation by Agnes.

Arriving Tuesday morning at the building at 100 North Cameron Street where I worked, I parked my car in what remained of the parking lot. Getting out of the car and surveying the area, the sight was one to inspire awe and disgust. Lumbering over to a group of people and exchanging greetings of the morning, I sensed by the inflections of their voices that they too shared the same emotion.

With everyone attired in old clothes, the area appeared to be invaded by junk collectors carrying out oil-soaked chairs and silt-covered warped desks. I ventured into the building and my first impression was that of being inside a sewer. At my feet was a treacherous mire of what had been ceiling blocks and other debris, oozing with black oil. All around me, up to and including the ceiling, everything was covered with oil. A distinct oil ring was left on the outside of the building, clearly marking the high water level, approximately 12 feet high. The upheaval of furniture demonstrated the angry forces of Nature. With rack and ruin, the flood water took its toll. Weighty cabinets filled with rock specimens were overturned. The offices were left in shambles, as if by the work of vandals. Water-swelled books had wedged so tightly in their bookcases that they had raised themselved off their shelves, making the use of a crowbar or hammer necessary to free them.



Destruction of the Survey's Rock Preparation Lab.

The Chemistry Laboratory had been in the process of being set up prior to the flood, with some of the equipment still in boxes from the big move from the Main Capitol Annex. The boxes now were turned to mush and the contents littered the floor. The X-ray Laboratory with its expensive electronic gadgetry, used only a few short weeks at Cameron Street, now lies dormant and dismembered, waiting to be rejuvenated or replaced. Walking through the hallway, I was astounded to find a sea of books had pushed a partition halfway into the hallway. Peering in from the doorway the heap of books appeared to be at least three feet deep in some spots and seemed to cover the entire floor of the library. The adjacent map room with its overturned map cases was in complete havoc, thousands of maps scattered all over the room. I could go on and on describing what I saw, but space would not allow.

After completing my tour I decided to roll up my sleeves and dig in, but with not much enthusiasm, I might add . . . Where to begin? My first thought was to search for dangerous bottled chemicals that might have floated out of the laboratory or become broken. Canvassing the hallway I found cases of glassware still intact, some distance away from the lab. Manuscripts also were a matter of concern; most were irreplaceable. Finding sheets plastered to the ceiling and other unusual places became 'old hat'. A specific gravity balance was 'pasted' to a wall 5 feet above its normal resting place. For some unaccountable reason one light on each telephone remained lighted although they were dead and all power was off. So it went.

Moving furniture out of the building was a joy all its own. All light was by flashlight. The floor littered with junk and the mire presented a real struggle, especially with the heavier pieces. It was necessary to pry or rip open desk drawers and cabinets in order to retrieve contents. For approximately 2 weeks this recovery operation went on. It was hard, dirty, and sometimes sickening work, due mostly to sewage smells. Now, four months later, order is slowly being restored although months of work remain. Though crippled we are back in business. Like the mythical Phoenix, we shall again rise from the ashes (or more appropriately, the rubbish) to better serve the Commonwealth.

Leslie Chubb

NATION USING MORE THAN 370 BILLION GALLONS OF WATER A DAY

As of 1970, the United States was withdrawing a total of 370 billion gallons of water a day from surface- and ground-water sources to meet the needs of public supplies, commerce, industry, irrigation, and rural users. This amounts to an average of about 1,800 gallons per day per person according to a recently published report of the U. S. Geological Survey.

The report notes that an even greater amount of water, some 2.8 trillion gallons per day, is used to generate hydroelectric power, but is not generally considered part of the Nation's "off-channel" use of water.

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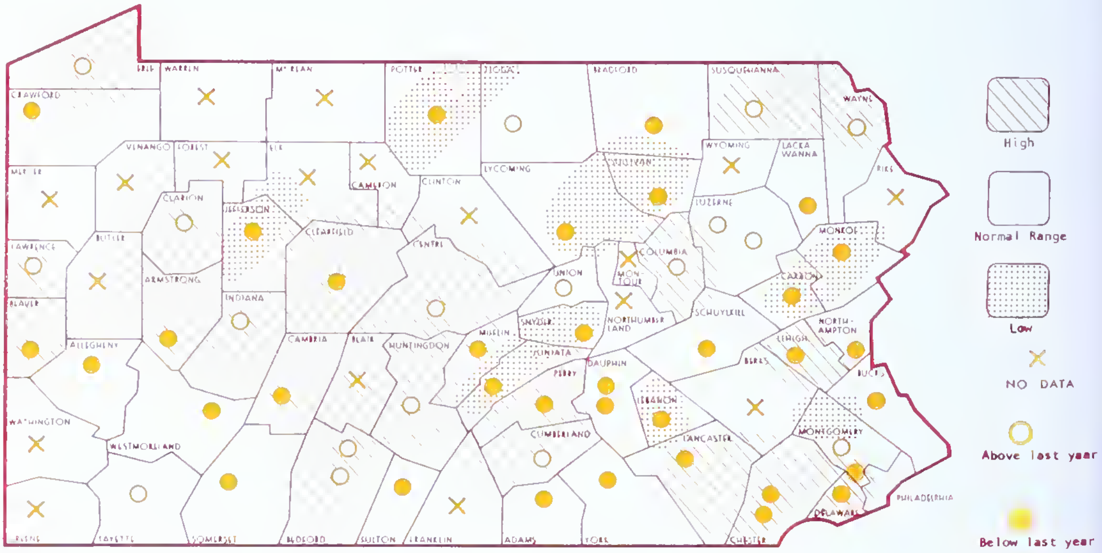

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VOL. 3/6

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DEPARTMENT OF ENVIRONMENTAL RESOURCES
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TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER – View along Susquehanna River near Liverpool where it cuts through the limb of one of the curving fold structures of the Appalachian Mountains. *Photo courtesy of Grant Heilman.*

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DECEMBER 1972

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

THE LESSONS OF AGNES

At the recent Minneapolis meeting of the Geologic Society of America, I was touched by the number of persons who extended their sympathy for our Survey's flood disaster, and who offered various forms of assistance. The response there and through the mails has truly been heartwarming and has made me prouder than ever of the geological profession.

One question which has been repeatedly asked of me is how a geological organization, knowledgeable in surficial processes, came to be located in a floodprone area. The answer, simply, is that pressures for space on the Capitol grounds had resulted in a decision to relocate us from our previous quarters in the Old Museum Building. Requiring a sizable area with special facilities to handle the needs of a Survey, the available sites were extremely limited.

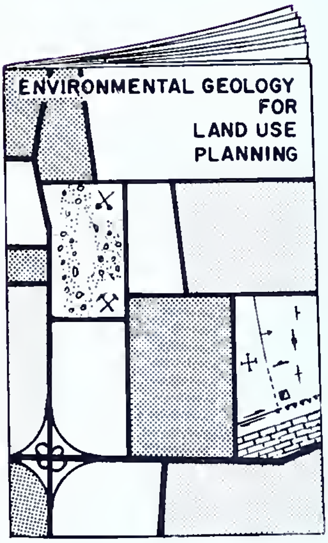
As we are struggling to rebuild, our hope is that all of Pennsylvania may be wiser from the experience of Agnes. There is clearly a need for a sound, statewide program of floodplain management which will prevent the double agonies of people being victimized by flooding while the burden of rescue and financial salvation falls on their fellow men and the taxpayers. We should not be lulled by the tidiness of the area as the heroic efforts have cleaned up the mess. Nor should we be consoled by misleading statistical probabilities of a so-called once-in-a-hundred-year flood, or two hundred year flood. Virginia recently had two once-in-a-hundred year floods within a twelve-month period. And what about the 500 or 1000 year floods on which we have no data?

Once and for all, we should recognize that certain locations have natural hazard potentials. We should have mandatory planning and regulate the use of such areas so as to forestall the suffering and costs to all. We speak from experience.

Arthur A. Socolow

GEOLOGY FOR LAND USE PLANNING - AN AID TO PLANNERS

What are the topographic limitations of the land available for expansion? Are major engineering modifications necessary to prepare the land for a specific use? Can the extraction of mineral resources be compatible with urban development? Will liquid and solid waste disposal sites be adequate? Are water resources adequate? These and many similar questions are discussed in a new publication recently released by the Bureau of Topographic and Geologic Survey.



"Environmental Geology for Land Use Planning", Environmental Geolory Report 2 explains what environmental geology is, why it is important, how it is used, and the major geologic factors that are involved. Continuing in the format of Environmental Geology Report 1, this pamphlet features the use of many photos and sketches to visually illustrate each subject. The pamphlet is designed to bring to the readers attention the effect of geology on man's activities, whether it be geological features as hazards or as resources. Geology is a valuable tool for planning, for conservation, and for wise use of the land. This report attempts to bridge the gap between basic geologic facts and the real-world, daily needs of a fast moving, ever changing society and man's impact on the face of the earth.

Geology has an important role to play in improving and protecting the environment of Pennsylvania. The Environmental Geology series of publications are designed to present information that will assist in defining the most effective use of our land and mineral resources. The Bureau of Topographic and Geologic Survey is pleased to make another contribution to better environmental planning and development.

Environmental Geology Report 2 may be obtained by writing to the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125. The cost per copy is $1.40 plus 6% state sales tax for Pennsylvania residents.

GEOLOGY IN THE PUBLIC DECISION-MAKING PROCESS

At the recent annual meetings of the Geologic Society of America at Minneapolis, a special session emphasized the growing importance and need for geology and geologists to be involved officially and individually in the decision-making processes of our society.

Presented below are the abstracts of two-papers which were presented at the Minneapolis meetings.

The Geologist in Environmental and Resource Decision-Making

Everett, A. Gordon, Director, Office of Technical Analysis, Environmental Protection Agency, Washington, D. C.

In the course of environmental and resource planning and management, geologists have two potentially important roles to play. The first is to provide the substantive physical and chemical framework, both static and dynamic, into which biological and other scientific, engineering, economic, social, and political factors can be placed. This requires clarity and completeness in the presentation of assumptions, data, processes, and projected consequences. It is critical that incomplete or omitted factors be noted as well, in order that decision-makers can assess the probabilities of alternative courses of action.

Beyond providing the physical setting for informed, effective decision-making, geologists can also serve effectively as leaders in the decision-making process. The breadth of considerations requiring knowledge from various disciplines such as is necessary in effective, broadly-interpretative geology is necessary in environmental and resource planning and management. The integration of processes in three dimensions, through time, is not customary in most other fields. The temporal factor, obviously critical in public environmental and resource considerations, is also necessary in private sector considerations.

Thus, geologists have both substantive and methodological contributions to make in the increasingly important decisions affecting the environment and resources, decisions which will ultimately determine the quality of life in America and the world.

Communication - Keystone Between Geological Science and Metropolitan Problem Solving

Zeizel, Arthur J., Office of the Assistant Secretary for Research and Technology, Department of Housing and Urban Development, Washington, D. C.

National priorities are shifting to apply science and technology to domestic problems. As these problems are concentrated in metropolitan areas and are chiefly the responsibility of State and local government, the geologic profession must help strengthen these governments. Provisions for putting geologic information into decision-making will remain inadequate until problems are prevented and environmental and social goals equal those of the marketplace. Professions and public officials are realizing the need to increase effectiveness by joining forces. Insights into mechanisms for improving multidisciplinary, problem-oriented research, user involvement, and technology transfer are emerging from an environmental planning research and demonstration project being conducted by HUD and the U.S.G.S. Lessons learned include the need for careful project design and management, multidisciplinary teams including planners, early, substantive, and continuous user involvement, early definition of user needs and products, and mechanisms for feedback and evaluation. Constraints to communication which must be overcome include inadequate appreciation of geologic information, difficulty in making scientific information understandable, and reluctance of geologists to work close to political processes. The Federal government is encouraging a partnership in science and technology with State and local governments. It is timely for the geologic profession to demonstrate its capability. What is required is expansion of the profession's role in urban affairs; willingness to work with policy, planning and operational personnel; increased influence upon the political process; and effective communication.

CLAY AND SHALE RESOURCES IN THE GREATER PITTSBURGH REGION – PHASE 1. ON OPEN FILE

The Bureau of Topographic and Geologic Survey, Department of Environmental Resources, in cooperation with the U. S. Geological Survey, is engaged in a two-phase clay-shale program under the Greater Pittsburgh Regional Studies Program. Phase 1. of this program is a comprehensive compilation of existing lithologic, physical, chemical, mineralogical, and use data on clay-shale samples from the six counties (Allegheny, Armstrong, Beaver, Butler, Washington, and Westmoreland) in the Pittsburgh Regional Study area. In accordance with the aims of this study, the early release of these data by placing this report immediately on open file should help provide for the optimum development, utilization and conservation of this important natural resource; and, also, make available mineral resource information that could lead to improved urban and regional land-use planning.

Phase 1. is now on open file at three locations: Bureau of Topographic and Geologic Survey, 401 Pittsburgh State Office Building, 300 Liberty Avenue; the U. S. Geological Survey, 102 East Mall (Second Floor), Carnegie; and the Bureau's Harrisburg Headquarters at 3rd. and Reily Streets. All interested persons are encouraged to examine this report at these offices. Copies of the report may be made available at the expense of the individual.

NEW GEOLOGY MAP OF CLARION COUNTY, PA.

The U. S. Geological Survey has released a new map showing the general geology and outcrop lines of coal beds in Clarion County. It consolidates and revises older maps covering parts of the county and extends mapping into portions not previously published. The map, entitled **Geologic and Coal-bed Map of Clarion County, Pennsylvania** (Map I-715) by E. D. Patterson and J. A. Van Lieu, is available for $ .75 from the following address:

U. S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202

AN ENVIRONMENTAL GEOLOGY FIELD TRIP

On November 9th members of the Bureau of Topographic and Geologic Survey conducted an environmental geology field trip for planners of the North-Central Regional Planning Commission at Ridgway in Elk County. The program was divided into two sessions. Mr. Jesse L. Craft of the Bureau's Environmental Geology Division opened the morning session with a presentation on "Questions Asked By Planners in the Evaluation of A Development Site". The morning continued with a short presentation of the general geology of the DuBois area, including Clearfield, Jefferson, and Elk counties, by William Bragonier of the Bureau's Field Geology Division. A lively question and answer period followed and concluded this session.

The afternoon program involved an environmental geology field trip through the DuBois area. The trip was conducted by Mr. William Bragonier, who with Albert Glover, has been mapping the geology and mineral resources of the area. The six stops visited in the afternoon included a sanitary landfill site in an abandoned strip mine of the Lower Kittanning Coal northeast of DuBois, an underground mine collapse near the Hummingbird Speedway, strip mine highwall stability problems, burning tailing piles and acid-mine ground water discharge problems and solutions.

The group participating in this field trip included county planners, county commissioners, soil conservantionists, soil scientists, and Geologic Survey personnel. Twenty-four people attended the morning session with sixteen of these braving the afternoon cold and mud on the field trip.

This type of seminar and field trip was a new experience for the Survey and we feel one that was promising and will be repeated in other locations of the state.

Alan R. Geyer

CLAM BURROWS IN THE UPPER DEVONIAN OR: "QUO VADIS *ARCHANODON?*"

Much of a field geologist's time is spent with his nose at the outcrop . . . searching. He pokes, scratches, hammers, peers, and generally sniffs out anything that might give him a new insight for interpreting the rocks. Since his interpretations and predictions may sway the balance of some pretty weighty economic decisions, he can't afford to overlook any clues.

One "clue" that we have learned to recognize and understand in the Catskill Formation of northeastern Pennsylvania is the fossil burrow made by an elusive clam during the Late Devonian (about 355 million years ago). The borrows are cylindrical and are generally perpendicular to bedding planes. They occur in the basal sandstone member of the Catskill and are easy to recognize with a little practice. The burrows vary from 3 to 5 cm. in diameter and are up to about 1.3 m. long. Some display internal crescentic structure (Fig. 1), the effect of burrow backfilling by the clam. These burrows are straight, curved (Fig. 2), or slightly sinuous. In some beds, several curved burrows tend to curve in the same direction. Cross sections of burrows as seen on bedding planes are either circular or elliptical; when elliptical, the long axes of the ellipses are sometimes aligned in the same direction (Fig. 3).

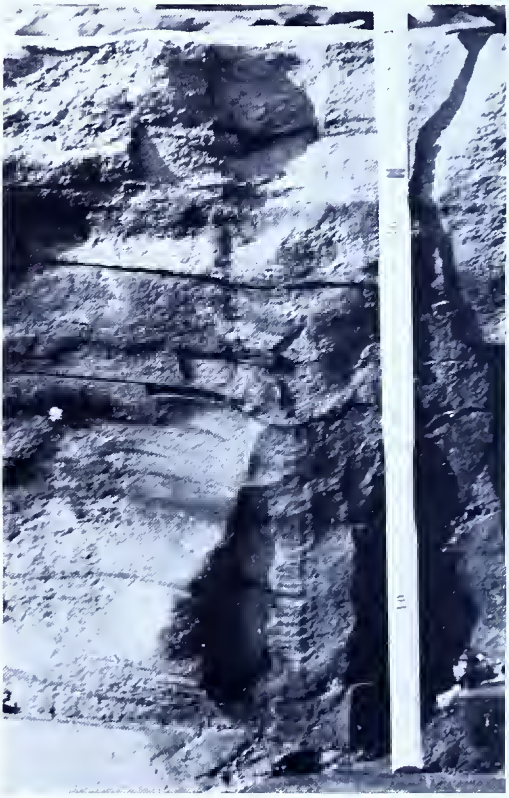


Figure 1. Crescentic structure in an *Archanodon* burrow, reflecting burrow backfilling by the clam. Scale marked in cm.

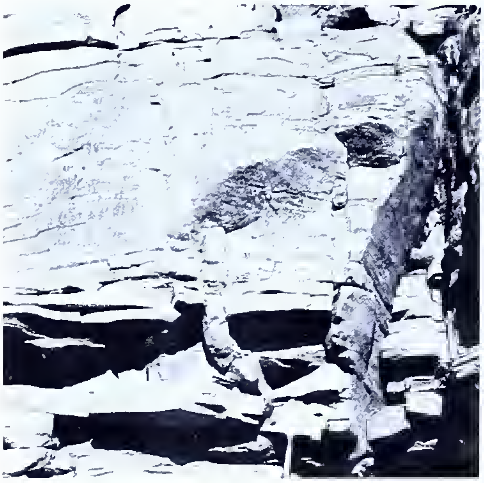


Figure 2. Curved pelecypod burrow in outcrop near Port Jervis, N.Y. Hammer gives scale.

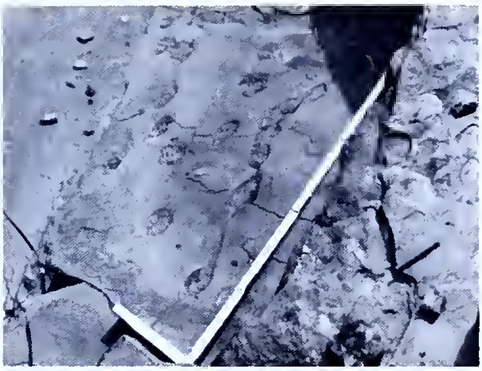


Figure 3. Bedding plane showing parallel orientation of elliptical burrow cross-sections.

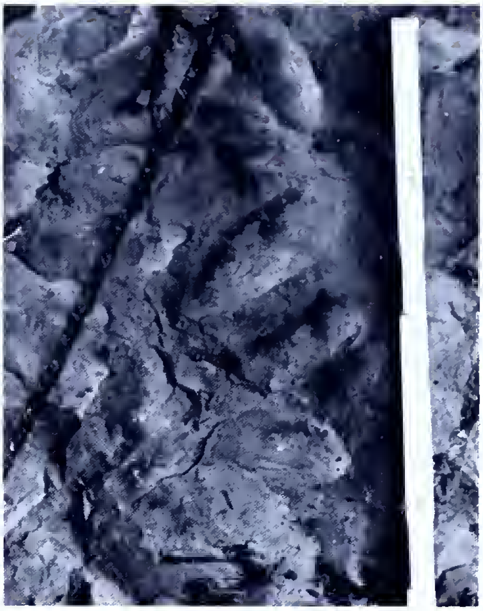


Figure 4. Molds of *Archanodon* sp. in sandstone outcrop, southern Carbon County.

At a key outcrop in southern Carbon County, Pennsylvania, abundant molds of the pelecypod *Archanodon* sp. (Fig. 4), are preserved along with the burrows. Other sandstone exposures in the outcrop belt as far as 65 miles to the northeast at Port Jervis, New York yield identical burrows, but no clams to date. The general shape of the fossils of *Archanodon* sp., the occasional parallel orientation of curved burrows, and the alignment of elliptical burrow cross sections are all features that bear a striking similarity to certain modern seaward-burrowing pelecypods that live in an intertidal beach environment. The primary sedimentary structures associated with the burrowed sandstones are also similar to those we find on modern sandy beaches. These sedimentary structures include plane bedding, medium scale cross-stratification, ripple marks, large scale cuspate features, and some parting lineations.

Previous interpretations of *Archanodon* have indicated that it was a freshwater pelecypod. If the specimens in the basal member of the Catskill are truly analogous to modern burrowing clams in the interidal zone, then further study of the paleoecology of *Archanodon* must be done.

The interpretation of Archanodon sp. as a marine clam confirms and amplifies the recent interpretation of J. D. Glaeser (Pennsylvania Geological Survey Staff) that the basal sandstone member of the Catskill was deposited in a tidally-affected environment, rather than a fluvial environment.

Assuming that *Archanodon* sp. was seaward-burrowing, the burrows that curve in the same direction in the same bed probably curve towards the location of the Late Devonian sea. The parallelism of elliptical burrow axes may also indicate a seaward direction since apparent modern analogues frequently orient their shell hingelines toward the sea.

In the study of sedimentary rocks, it is often a single clue, like the remains of a clam, that completes the picture of an ancient depositional environment.

When we better understand how and where the rocks were formed, we can better predict their lateral extent and degree of variability. This degree of understanding is important in the case of such rocks as the basal sandstone of the Catskill Formation; natural gas shows have been recorded at this horizon in several exploratory wells drilled in northeastern Pennsylvania. If the basal sandstone of the Catskill was deposited in a tidally-affected delta front environment, the unit will be sheetlike in its distribution, in contrast to the more belted nature of fluvial deposits.

Thomas M. Berg
Field Geology Division

U.S. BUREAU OF MINES LIAISON OFFICE

Recognizing the mutual concern of the U. S. Bureau of Mines and the States for effective and wise utilization and conservation of mineral resources, the U. S. Bureau of Mines has implemented a liaison program to expedite Federal, State and Industry cooperation in this area. The Liaison Office promotes cooperation in programs reflecting mutual concern for the effective and wise utilization and conservation of our national mineral resources with adequate environmental protection. Mr. Arnold H. Harvey has been appointed as the Liaison Officer for Pennsylvania by the Bureau of Mines, representing the Director and serving as a Federal point of contact.

Mr. Harvey received his Mining Engineering education from The Pennsylvania State University. His understanding of the mineral activities in Pennsylvania was broadened through twenty years of experience as Chief Engineer and Assistant Superintendent in various anthracite mines. He also has a thorough knowledge of bituminous mining and its associated problems, and has had close contact with other related mineral industries in the Commonwealth.

Since Mr. Harvey has been with the Bureau of Mines, he has been responsible for managing and coordinating Federal-State projects under authorized programs for the control of and extinguishment of underground and outcrop coal mine fires, surface subsidence control, and mined land reclamation. These projects, for the greater part, have been located in the bituminous and anthracite regions of Pennsylvania.

Mr. Harvey has established an office in Room 334, Federal Building, Harrisburg, Pennsylvania. He is available to render technical assistance or supply information to Legislators, State officials, mineral industry representatives, educational institutions and interested citizens regarding Federal cooperative programs. His mailing address is P. O. Box 783, Harrisburg, Pennsylvania 17108.

KINK BAND FOLDING IN CENTRAL PENNSYLVANIA - III

The kink band folds in the Valley and Ridge province exhibit a variety of profile (cross-section) geometries. Some are upright and symmetric; others are inclined and asymmetric; a few are even recumbent. Many are simple folds, with two limbs and a single axial surface; others are conjugate, with three limbs and two axial surfaces. In view of this geometric variety, the question arises whether kink bands can be arranged in different ways to reproduce all the observed profiles.

As simple as single kink bands are, they are by no means uniform. As demonstrated previously (Pennsylvania Geology, v. 3, no. 1, p. 6-9) kink bands of all sizes occur in this province. Although kink bands are usually inclined to the enveloping bedding* at about 60 degrees, a considerable divergence of 45 to 90 degrees has been observed. Similarly, the amount of bed rotation within kink bands can vary from 10 to 120 degrees. With this variability in kink band geometry, it is not surprising that resulting kink band folds also exhibit profile variability.

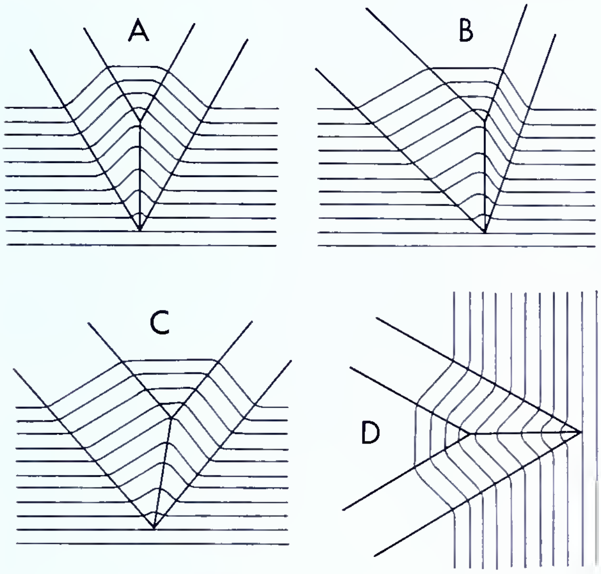


Figure A. Variation of fold profile geometry as a function of variations in kink band arrangements. a. an upright, symmetric fold. b. An upright, asymmetric fold. c. An inclined, asymmetric fold. d. A recumbent, symmetric fold.

If two kink bands are of equal width, equal amount of bed rotation (but in opposite senses), and oppositely inclined to the enveloping bedding, then the resulting fold at their junction will be upright and symmetric (Figs. Aa and B). On the other hand, if the kink bands are of different amount of bed rotation, and are inclined to the enveloping bedding by different amounts, the resulting fold at their junction will be upright and asymmetric (Fig. Ab) or inclined and asymmetric (Figs. Ac and C).

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* Enveloping bedding is the attitude of the beds outside of and surrounding the fold, kink band, or other structure in question. Rather than the horizontal datum, the enveloping bedding is used as a local datum to simplify discussion of the geometry of the structure. To visualize this principal, rotate Fig. B and D such that the enveloping bedding appears horizontal.

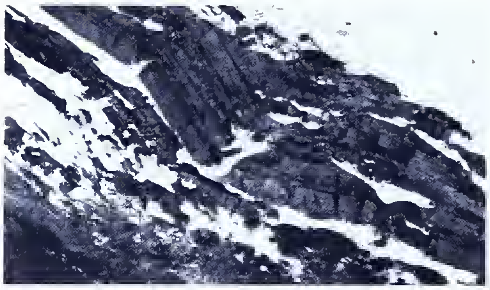


Figure B. A symmetric, low amplitude kink band fold in the Mahantango Formation, along Cocolamus Creek 2 miles north of Millerstown, Pa. Although the axial surface of the fold is inclined relative to the horizontal datum, it is upright (perpendicular) relative to the enveloping bedding.

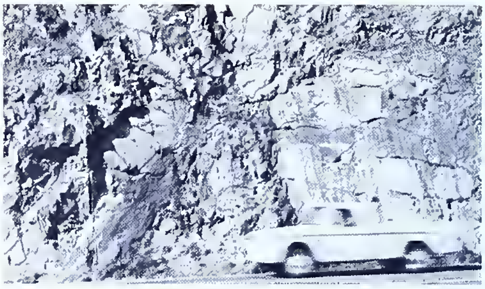


Figure C. An asymmetric, nearly upright anticline in the Wills Creek Formation, along Rt. 22, 6 miles northwest of Huntingdon, Pa.

The presumption in these examples has been the enveloping bedding is horizontal. However, many small folds occur within the limbs of larger folds (thereby imparting a complexity to the larger folds which justifies the terms anticlinorium and synclinorium). Because the bedding in the large fold limb possesses a dip between 1 and 90 degrees, all the smaller folds will be similarly inclined. As an extreme example, if the bedding in the larger fold limb is vertical, the enclosed fold is recumbent (relative to the horizontal datum) even though it upright and symmetric relative to the enveloping bedding (Fig. Ad). A recumbent fold, that is inclined and asymmetric relative to the enveloping bedding, is illustrated in Figure D.

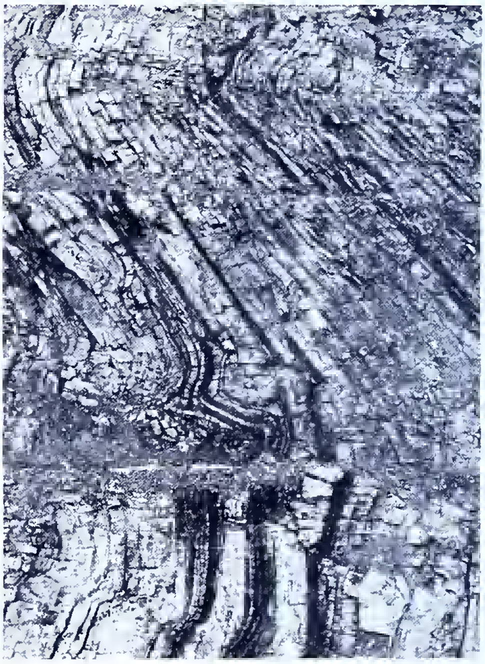


Figure D. A recumbent, asymmetric syncline in nearly vertical beds of the Tuscarora Formation, along Rt. 322, 2 miles northwest of Milroy, Pa.

The majority of the folds in the Valley and Ridge province are simple, possessing only two limbs and a single axial surface. Yet folds with three limbs and two axial surfaces, conjugate folds, are not uncommon. Conjugate folds and simple folds are actually two parts of the same kink band structure, as can be seen in Figure E. Where two inclined kink bands join, a simple fold geometry results. Above this junction, where the two kink bands are separated by an unrotated *interlimb*, the single axial surface bifurcates into two axial surfaces, which are the kink planes of the two kink bands.

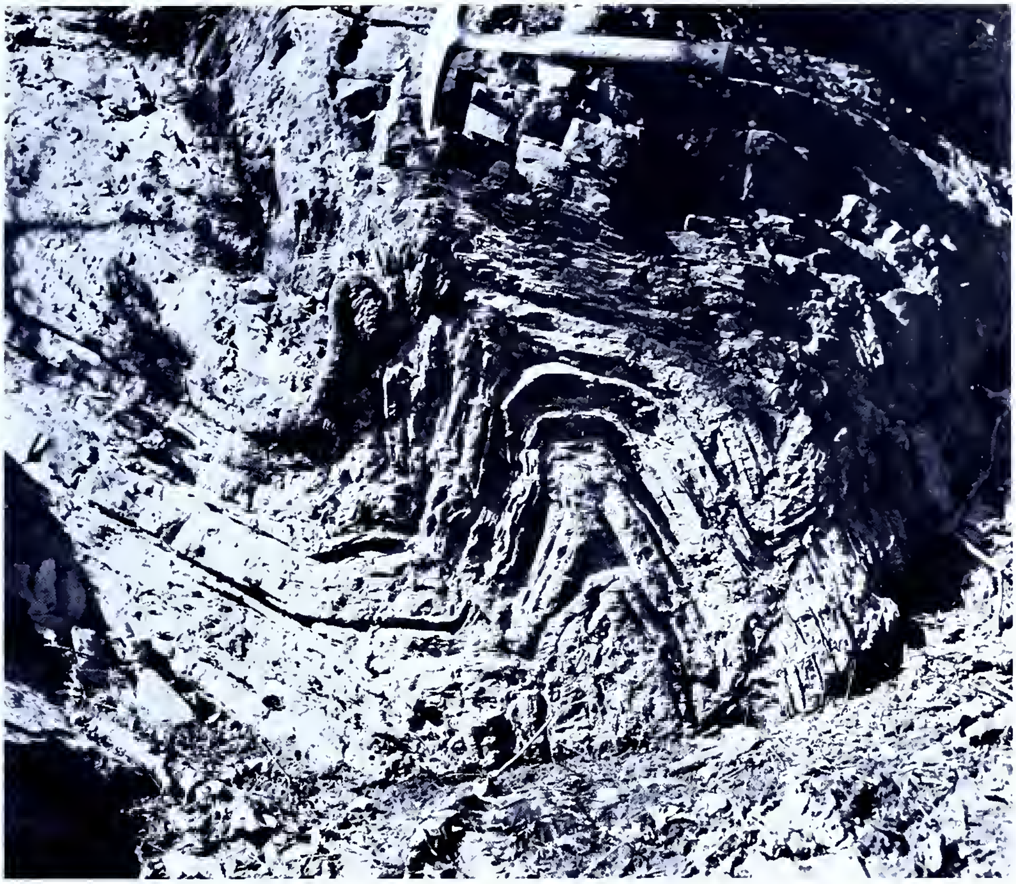


Figure E. A combined conjugate and simple anticline in the Wills Creek Formation, on the west bank of the Juniata River and 6 miles northwest of Huntingdon, Pa. Above the simple fold, the two kink bands are separate and a conjugate fold is present.

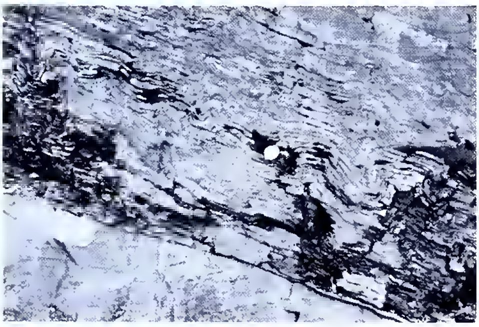


Figure F. Two oppositely inclined kink band arrays producing a continuous train of folds in a laminated bed. Wills Creek Formation along Rt. 22, 6 miles northwest of Huntingdon, Pa.

The combination of conjugate and simple folds can be seen in the kink band array developed in a laminated bed (Fig. F). Two sets of kink bands oppositely inclined have produced a nearly continuous train of folds of various geometries. Because of the similarity of these small fold geometries with the largest ones in the province, this small array is a reasonable model of the large folds across the entire province.

Rodger T. Faill

PENNSYLVANIA ANTHRACITE IN 1971

Latest figures just released by the U. S. Bureau of Mines show that anthracite production in Pennsylvania was 8.7 million tons, down 1023 percent from the previous year. The production came from 155 underground mines (producing 15 percent of the total), 180 strip pits (producing 51 percent of the total), 81 culm and silt banks (producing 30 percent of total), and 8 dredging operations (producing 4 percent of total).

Decreased domestic consumption (down by 11 percent) and much smaller foreign demands were the major factors responsible for the decline in anthracite production.

Schuylkill County, with 3.6 million tons, and Luzerne County, with 2.6 million tons, were the leading anthracite producers. Other anthracite producers of record were Northumberland, Lackawanna, Carbon, Columbia, Lancaster, Sullivan, Snyder, and Berks.

The anthracite production industry employed 5800 men in 1971 and the average value of the coal at the plant was $12.08 per ton.

PENNSYLVANIA MINERAL PRODUCTION RISES

Pennsylvania mineral production in 1971 showed an increase of 4.9 percent over the previous year, attaining a raw material value of $1.15 billion, the fifth highest in the nation.

Coal again was the leading mineral commodity, accounting for 62 percent of the total value and showing an increase over the prior year despite a 44 day work stoppage. The value of cement products, the second ranking mineral commodity in Pennsylvania, also showed an increase, up to $152 million. Sand and gravel products showed increases for the year, while copper showed an impressive 32 percent production increase over 1970. Production of stone, lime, petroleum and natural gas each held pretty much at the level of the previous year.

SEDIMENT THANKS TO AGNES

The Pennsylvania Department of Environmental Resources reported that 8,130,800 tons of suspended sediment were discharged by the Susquehanna and Schuylkill Rivers as a result of Tropical Storm Agnes. Of the total, 7,430,000 tons were recorded for the Susquehanna River at Harrisburg and 700,800 tons for the Schuylkill River at Philadelphia. The total amount of sediment discharged on the two rivers was equivalent to approximately one-half inch of soil from 203,000 acres.

The sediment load normally carried past Harrisburg in three years was carried past the city in 10 days during the flood. At Philadelphia, 2.6 times the normal annual sediment load for the Schuylkill River was carried past in four days.

SURVEY ANNOUNCEMENTS

SURVEY RELEASES NEW BIBLIOGRAPHY OF PENNSYLVANIA GEOLOGY

The **"Annotated Bibliography of Pennsylvania Geology - Supplement to 1969"** by Howard Ross Cramer was published last month.

This new publication may be purchased for $5.00 from the State Book Store, Tenth and Market Streets, Harrisburg, Pennsylvania. Mail orders with payment of $5.00 plus $ .30 sales tax for Pennsylvania residents should be sent to Department of Property and Supplies, Bureau of Management Services, State Book Store, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Checks or money orders should be made payable to the Commonwealth of Pennsylvania.

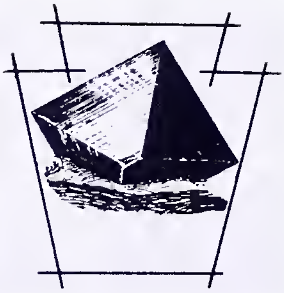
This publication is the third bibliography published by the Survey. The others are Bulleting G-34 and G-42 which sell for $5.75 and $2.30 respectively.

The new hard cover volume of 345 pages contains annotated, alphabetical listings of publications pertaining to geological investigations in the Commonwealth. It is a continuation or, and supplement to the earlier bibliographies which include publications to 1959. The new bibliography contains citations, annotations, and indexing not only of those articles dated from 1960 to 1969, but those of earlier dates which were not included in the other two publications.

The book includes a listing of scientific publications cited; a bibliography by author's name and an index by county, subject and geologic age.

GEOLOGIST JOINS SURVEY STAFF

We are pleased to announce that Mr. Evan T. Shuster has joined the staff of the Pennsylvania Geological Survey at the Survey's Harrisburg office. Working as a member of the Environmental Geology Division, Evan will be primarily responsible for carrying out the Division's goals and objectives in the subject area of ground water. He received his Bachelor of Science Degree from The Pennsylvania State University in 1966 and his Master of Science Degree from the same university in 1970. Evan Shuster's professional experience includes work as a research assistant in the Mineral Conservation Section at Penn State on various ground water projects and recently with the Division of Minerals in the Bureau of Forestry, as their ground-water geologist. He has written several professional papers and is a member of several state and national geological societies. Evan, his wife and daughter reside in Harrisburg.



EARTH SCIENCE TEACHERS' CORNER

secondary earth science education in pennsylvania

A Progress Report

During the past year, a study has been underway at Temple University to determine the present status of earth science teachers and earth science programs in the public secondary schools of Pennsylvania (reported in "Pennsylvania Geology" magazine, Vol. 3/2). Although the final analysis of data is currently in progress, a comparison of results from this survey and the 1969 survey by Geyer and Shirk is presented to illustrate trends over a period of three years.

Earth Science Teacher Preparation	**Cross**	**Geyer and Shirk**
1) Holding Master's Degree	44%	35%
2) Years of total teaching experience	9%	8½%
3) Years of earth science teaching experience	5½%	3½%
4) Teachers reporting institute participation	64%	54%
5) Attended institutes in earth science/geology	45%	63%
Attended institutes in earth science areas (i.e. meteorology, oceanography, etc.)	67%	*
6) Teachers majoring in earth science/geology at undergraduate level	32%	10%
7) Teachers having no courses in earth science	11%	20%

Earth Science Programs

Texts in use:	Cross		Geyer and Shirk	
1) ESCP - Investigating the Earth	20%	65%	19%	74%
2) Namowitz - The World We Live In	23%		30%	
3) Ramsey - Modern Earth Science	22%		25%	
4) No single text dominant	15%		*	

(*Not applicable to survey)

In the Geyer and Shirk survey a population of 400 included secondary teachers teaching earth science at least one semester or teachers using an earth science text for part of a general science course. This survey covered the 1967-68 school year. Whereas, the Cross survey included a population of 265 teachers teaching at least 50 per cent of their classes in earth science and certified to teach earth science, according to the annual Secondary School Report. The Cross survey covered the 1970-71 school year. It should be noted that the characteristics of the populations as defined for each study would cause one to expect the teachers in -the Cross study to have stronger earth science background.

Whitman Cross II

References

Cross, Whitman II (in progress), **Status of Earth Science Programs and Profile of Earth Science Teachers in Public Secondary Schools of Pennsylvania: 171-72.** Doctoral Dissertation, Temple University.

Geyer, A. R. and Shirk, W. R. (1970), **Pennsylvania's Secondary School Earth Science Course—Ten Years of Progress.** Journal of Geological Education, v. 18, n. 3, p. 118-121.

summer scientists at seneca valley high school

Girls using forel water comparator and secchi disk. Prince Gallitzin State Park.

Twenty-six Seneca Valley sophomores participated in a four-week summer science course entitled, "Field and Laboratory Experiences in the Environmental Sciences". Each student became an environmental scientist for four weeks. The course included the environmental sciences of geology, zoology, botany and limnology working under the leadership of Mr. Thomas Konvolinka and Jeffery Wilhelm. In addition to learning field-study techniques and the use of scientific equipment in these sciences, the course was highlighted by a five-day camping trip to Prince Gallitzin State Park in the foothills of the Allegheny Mountains.

The 460-acre lake at Prince Gallitzin State Park and the surrounding mountains served as a classroom for such activities as water sampling, coring and dredging the lake bottom, seining, navigational techniques, map interpretation, exploration of limestone caves and underground coal mines and the geology of the Horeshoe Curve.

Part of the four weeks provided time to use the laboratories in the new Seneca Valley Junior High School where tests and additional studies were made of the samples and collections of rocks, plants, animals and lake sediments.

Many students felt that these four weeks in the field were of greater value than a whole year in the classroom.

Students preparing H_20 sampling bottle. Photo taken on Lake Glendale in Prince Gallitzin State Park.

NEW HISTORY OF PITHOLE, EARLY OIL BOOM TOWN OF VENANGO COUNTY

Pithole, the Vanished City, by Professor William C. Darrah is a fascinating new book on the history of Pithole, Pennsylvania's fabulous oil boom town. Pithole sprang up in the Venango County wilderness in 1865 following a nearby oil strike. Within three months Pithole had blossomed into a sprawling, lusty community of 20,000, complete with homes, stores, large hotels, and all the other elements of a small city. Two years later the speculative bubble burst and Pithole went into a rapid decline. Today not one building remains.

In addition to being a highly-readable, well-researched history of Pithole itself, Dr. Darrah's book also provides an exceptional insight into early developments in the operations and technology of the American oil industry.

Pithole, the Vanished City is thoroughly documented for historical accuracy and amply illustrated with dozens of contemporary maps and photographs.

William C. Darrah is a member of the faculty at Gettysburg College and an eminent paleobotanist. He is also the author of ten other books including **Powell at the Colorado** and **Stereo Views: A History of Stereographs in America.**

Pithole, the Vanished City can be obtained for $8.50 per copy (post-paid if payment accompanies order; Pennsylvania residents add 6% sales tax) from Professor William C. Darrah, R. D. 1, Gettysburg, Pennsylvania, 17325.

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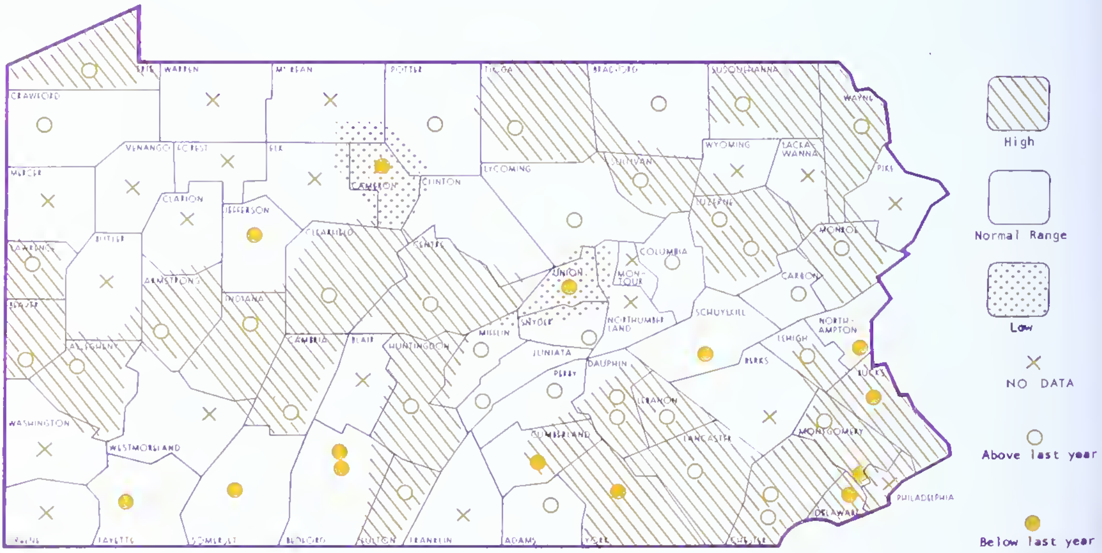

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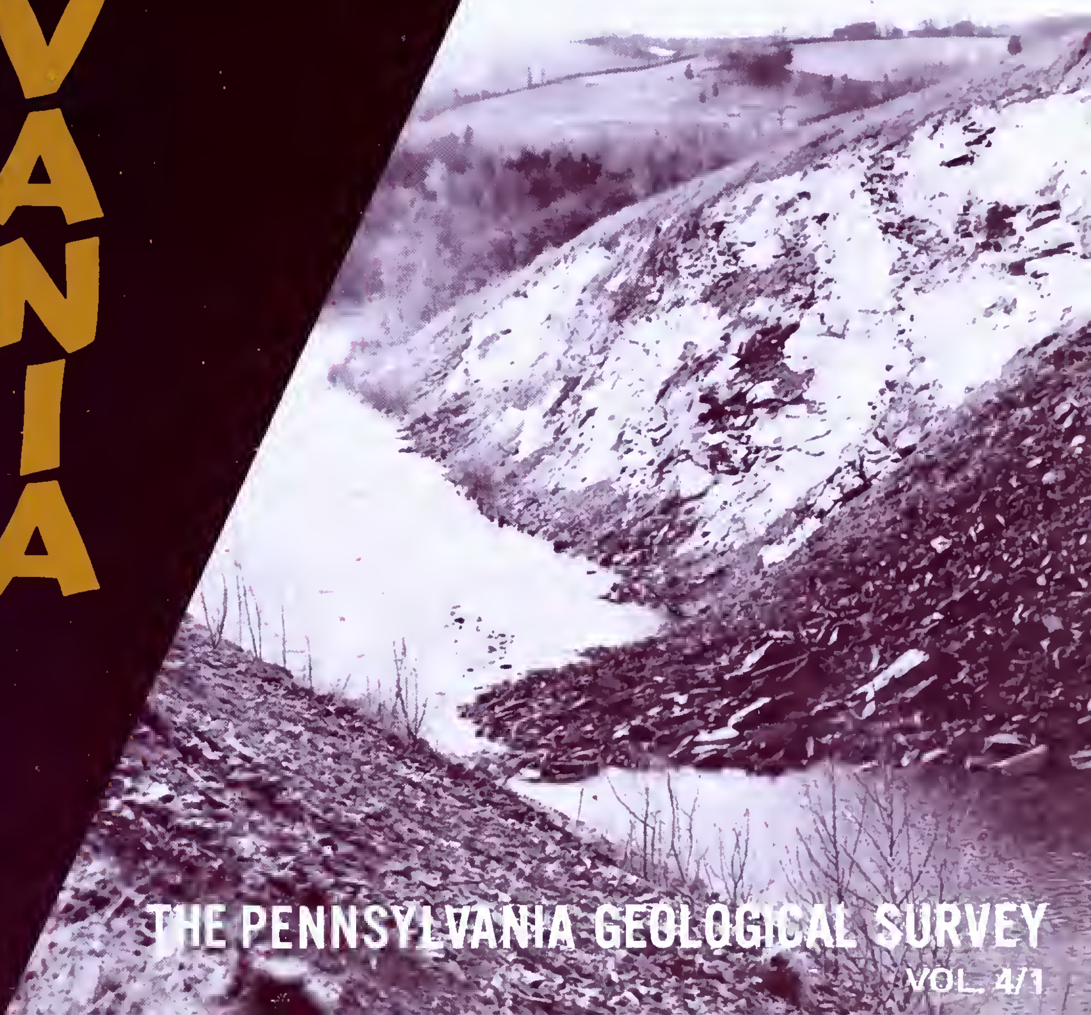

THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 4/1

COMMONWEALTH OF PENNSYLVANIA
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TOPOGRAPHIC AND GEOLOGIC SURVEY
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ON THE COVER — A landslide in Luzerne County due to a poorly designed stream relocation. Too often the geologic factors are overlooked in planning such projects.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

FEBRUARY 1973

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

HOLES IN THE GROUND---HIDDEN ASSETS

In recent years we have had a number of inquiries which suggest that a hole in the ground may be an asset. First we were approached if we knew of any dry, abandoned mines which could be converted into safe, records storage centers. Such adaptations already exist in other parts of the country.

Then there was the mushroom grower who came seeking guidance to abandoned mines as ideal sites to expand Pennsylvania's mushroom industry. Mines and caves have been adapted for mushrooms in many parts of the world.

At the recent AIME meeting a paper was presented on the merits of utilizing mines under certain favorable conditions as inexpensive reservoirs for large quantities of potable water. Similarly, if properly sealed, such mines could serve as natural gas storage reservoirs for an industry that needs storage capacity to cope with peak demands.

A year or so ago, a particularly novel idea was put forth to us, whereby a huge cavity would be excavated in bedrock, beneath one of our major cities in order to facilitate a pump-storage type of electric generating plant. The principle would be to let river water drop down into the deep void, moving past electric generators during peak electric demand. Then, during off-hours when demand was low, the water in the underground would be pumped out by surplus electricity. This is a reverse of the usual pump-storage facilities around the country where surface reservoirs are created on high ground and the water is pumped uphill during low demand. The subsurface reservoir has the advantages of (1) being located where needed, (2) better safeguards from pollution, and (3) much less environmental impact than a surface reservoir. Furthermore the rock obtained from the excavation could probably be sold to offset some of the excavating cost.

With surface mining and quarrying operations being subjected to more and more environmental restrictions and higher operating costs, it would seem that there may be a real future in having those operations go underground. Our industrial society needs the continued availability of the raw minerals being produced. Going underground would provide those minerals, with minimal environmental impact, and with subsurface voids that are becoming very marketable.

Once there was the anecdote about the oil well that was drilled and proved to be a dry hole. Along came an interprising young man who bought the well hole, cut it up, and sold the pieces for post holes. Maybe that idea is not so far fetched. There is a use for holes in the ground.

Arthur A. Socolow

LANDSLIDES: AN EARLY SPRING HAZARD

OR

THE CREEP THAT WOULDN'T SLOW DOWN

A potential problem exists along many of the hillsides and road cuts of Pennsylvania this spring. The unusually high water tables, especially in central Pennsylvania where 1972 was a record year for rainfall, and the lateness of the ground frost have brought many of the soils and weathered rock material to the point of saturation. After the spring thaw and rains arrive, perhaps all of this unconsolidated material will be saturated. This will be the time to expect three common types of landslides.

Along bedrock road cuts debris or rock slides will tend to occur. These result from soil mositure entering the fractures and joints of the rock, especially near the upper edge of the cut. As this water freezes, it expands, enlarging the fractures a small amount. If a thaw occurs the ice will melt and water will refill these same cracks. Another drop in temperature will freeze the water again and force the fractures open further. This cyclic freezing and thawing will occur throughout the winter until, during some thaw period, the rock and soil material sloughs off into the road cut. An examination of the top of road cuts will frequently disclose these expanded joints before sliding takes place.

Engineers and geologists have long known that the internal strength of unconsolidated material diminishes greatly as its water content increases. When saturated the material becomes unstable to varying degrees. This is the basic cause of the two other common types of landslides.

Everyone has seen lobes of mud moving slowly down steep embankments. These mud flows can sometimes be catastrophic, as in the Los Angeles area of California. This type of instability requires special conditions, usually a very heavy, prolonged rain on unprotected soil.

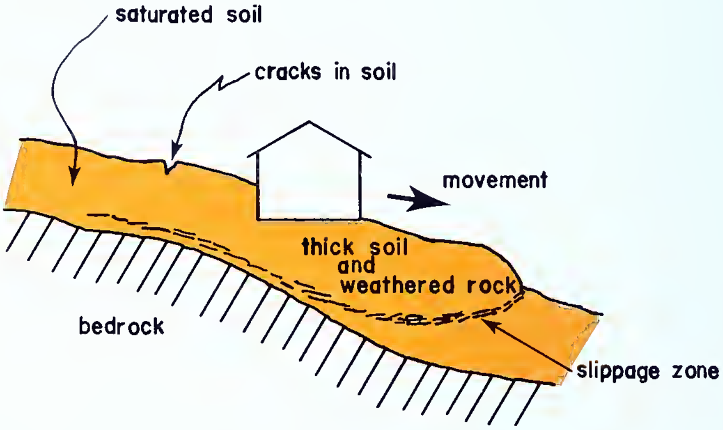


FIGURE I. FOUNDATION ON UNCONSOLIDATED MATERIAL

The other type of landslide, which is generally more gradual, is an accelerated form of soil creep. This can occur in fairly stable soils and on relatively shallow slopes if soil conditions are extremely wet and ground waters are high. Accelerated creep is more likely than the other types of slides to occur on slopes where houses or other structures have been built. Even this slower form of landslide can cause structural damage, from ceiling cracks and warped door jams to complete destruction of the foundation and downslope movement of the house. Early evidence for creep is the development of a sudden tilt to fence posts, trees, etc., the misalignment of fence and shrub rows, and sometimes the appearance of cracks along the slope where it steepens.

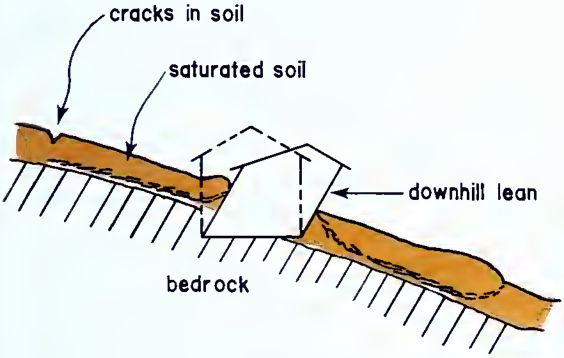


FIGURE 2. FOUNDATION ON BEDROCK

Several different situations involving accelerated creep can occur, but only two are illustrated in this article. Figure 1 shows a house on a moderate slope with its foundation on weathered rock material. The whole mass of soil has become saturated and is slowly moving downhill, including the house. Since these semi-fluid masses seldom move in a uniform manner, the foundation is also subjected to twisting forces. Figure 2 shows a house which is anchored in bedrock. In this case the soil mass is moving down on the house causing a downhill lean.

Since excess water is the cause of this particular sliding problem, the solution lies in removing this water. The soil mass will become more stable as the moisture content is reduced. If the discharge of ground water is creating the hazard as illustrated in Figure 3, wells can be drilled into the discharging aquifer and pumped to lower the water table (piezometric surface). If ground water does not play a significant role and the problem is caused chiefly by excess soil water, an array of auger holes can be drilled to intercept and drain the excess water. Figure 4 is a plan view of a hypothetical auger hole installation. In both

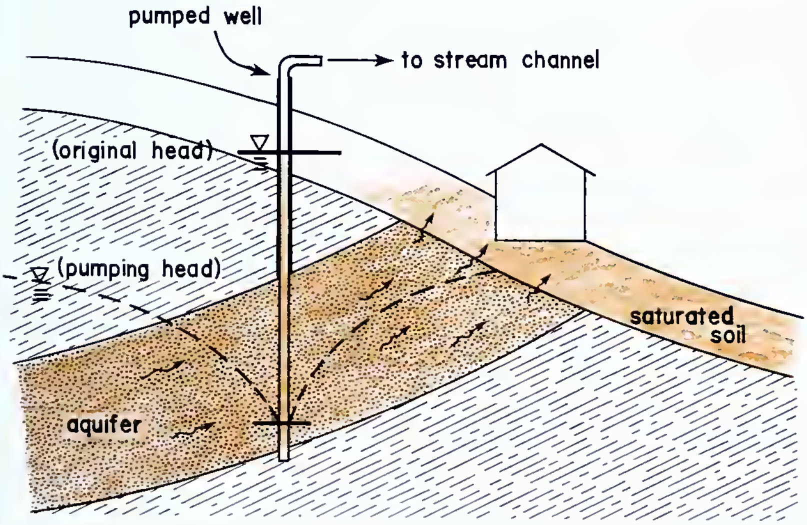


FIGURE 3. PUMPED WELL REDUCING THE AMOUNT OF DISCHARGE AND THE HEAD ON THAT DISCHARGE.

cases care must be taken to pipe the collected water into a stream channel. Discharging this water into the soil below the house may create erosion or sliding problems for any structures below.

Slides are complicated functions of the specific soil properties of the site, the topography, the geologic structure, the rock type, the soil and ground-water systems, as well as recent climatic events. Identification of potential hazard areas and the solutions to specific sliding problems obviously requires the expert advice of the geologist or geological engineer. The design and operating procedure of an installation to prevent or stop a slide should also be handled by the geologist.

Even after water has been drained from the soil there is no guarantee that the hazard has been eliminated. Once a slide has established itself, a zone of weakness forms within the mass along which subsequent movements are more than likely to occur. In these cases preventative measures must be revived during succeeding wet seasons, or structural solutions found to stabilize the slope.

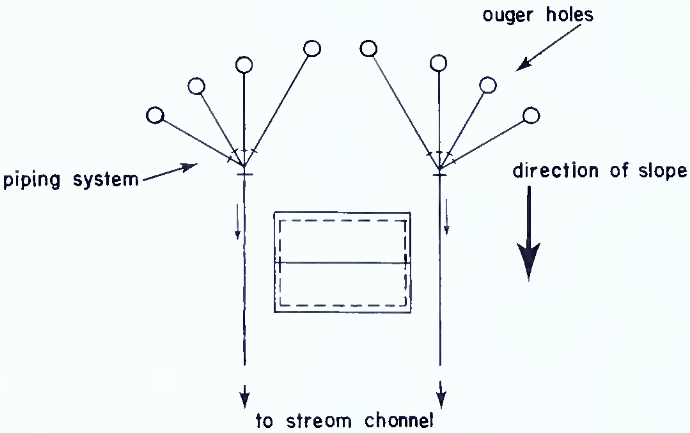


FIGURE 4. MAP VIEW OF AUGER HOLE ARRAY FOR DRAINING SOIL WATER

Evan T. Shuster

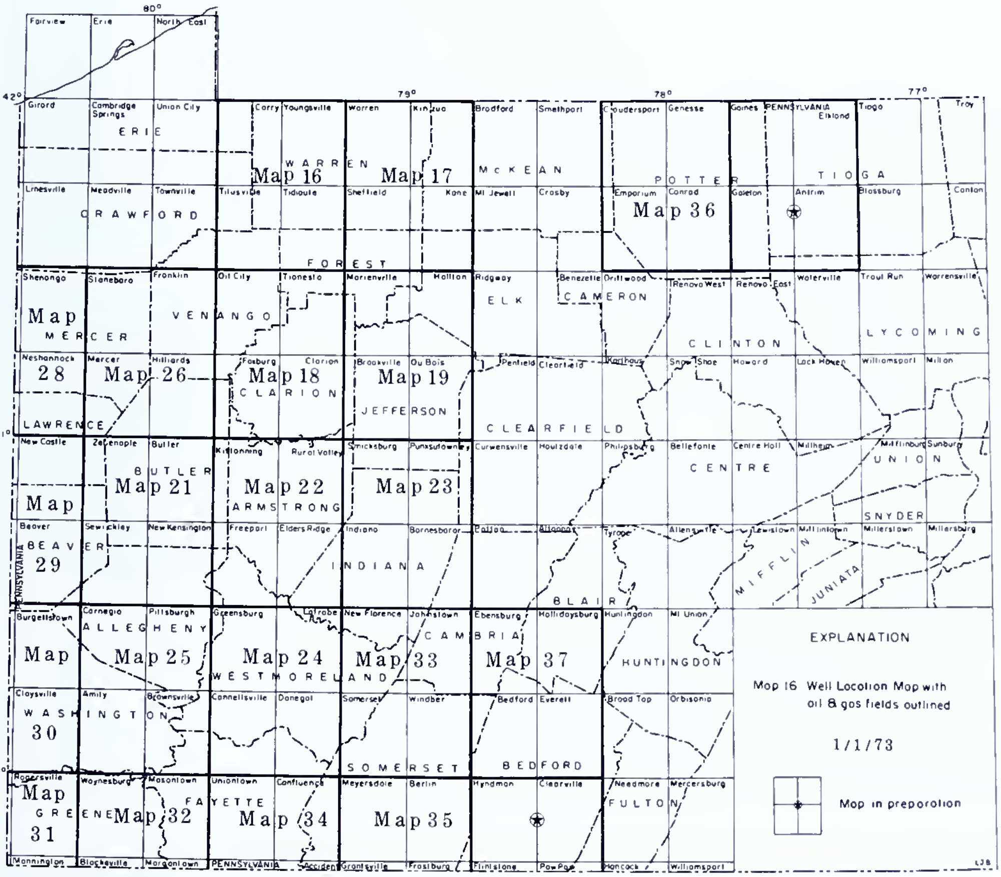
OIL AND GAS BASE MAPS AVAILABLE

Twenty base maps (see index map) showing locations of oil and gas wells and the outlines of the oil and gas fields are now available. Each base map encompasses four, 15-minute topographic quadrangles and is at the same scale of 1 inch equals a mile. A five-minute grid, quadrangle name, county boundaries, and major rivers and towns make up the background of the base map. All deep wells known and all shallow wells on record with the Pennsylvania Geological Survey are located, and the status (dry, oil producing, gas producing, etc.) are shown by symbol. Deep wells (Tully Formation or deeper) are differentiated and elevation and total depth are shown. Symbols indicate the availability of geophysical log and sample data on open file in the Survey's Oil and Gas Division office in Pittsburgh. An index map with the legend shows the outlines of oil and gas fields within the mapped area, thus indicating areas of extensive pre-1956 drilling. A listing of the field names is also included.

Paper prints of the base maps can be obtained by writing to the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125. Cost of each base map is $0.50, plus 6 percent state sales tax to Pennsylvania residents. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering please specify the map number.

A cross index of state permit numbers with quadrangle map numbers used on the base maps is available from the Pittsburgh Branch of the Pennsylvania Geological Survey, 401 Pittsburgh State Office Building, 300 Liberty Avenue, Pittsburgh, Pennsylvania 15222. This index is arranged by quadrangles. Please specify the quadrangle when requesting this listing. Base maps are updated every six months. Maps now available were updated as of 1/1/73.

William S. Lytle



We have moved again! Our new office address is Towne House Apartments, 660 Boas Street, Harrisburg 17102. Our mailing address is Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg 17120.

A NEW TRIASSIC COPPER OCCURRENCE AT ROSSVILLE, PA.

Last spring, an interesting occurrence of malachite and azurite on fractures in hornfels (a sediment baked by an igneous rock, in this case diabase) was reported to the Survey by Mr. Chester Griest of Dover. A short time later, Mr. Jay Linninger of Dillsburg donated some colorful specimens of this material.

One week before the flood, the occurrence, located 0.65 mile northwest of Rossville, York County, was visited by survey geologists B. J. O'Neill and B. C. Smith, II. At that time, six channel samples were collected through the mineralized beds. One of these samples, a mixture of red and brown oxides from a possible fault on the southwest side of the roadcut, was destroyed in the flood. The other five channel samples were carefully scrubbed piece by piece, rebagged, and sent out for Cu, Ag, and Au assays and Pb-Zn trace analyses. The following results were obtained:

Sample	Cu%	Au oz/ton	Ag oz/ton	Pb ppm	Zn ppm
1	2.0	.028	.26	150	195
3	1.1	$<$.005	.16	50	120
4	.38	.016	.19	60	120
5	.04	$<$.005	.43	25	55
6	.11	$<$.005	$<$.01	20	110

Sample 1 represented the main, 14"-thick, mineralized bed on the northeast side of the roadcut. Sample 3 represented the same 14"-thick bed on the southwest side. Sample 4 represented a 29"-thick interval directly above Sample 1. Sample 5 represented a 36"-thick altered greenish bed directly above Sample 4. Both O'Neill and Smith felt that this section might have contained more copper prior to weathering. Sample 6 represented a 40 ± 6"-thick section 30 feet northwest of Sample 5. The beds in the cut strike N31°E and dip 16°NW except near the possible fault close to the northwest end of the southwest side of the roadcut where the attitude is N52°E and 20°N. All observed mineralization is located in favorable beds.

Examination of polished sections with reflected light shows that the primary sulfides are either chalcopyrite or bornite, both successively rimmed by digenite and chalcocite. The bornite contains lamellae of chalcopyrite and traces of idaite. Silicate minerals observed by the authors include chrysocolla, epidote, garnet, actinolite, and stilbite.

Several small Cornwall-type iron-copper deposits are known to the southwest of this occurrence.[1] It has been suggested that the diabase to the north of the Rossville occurrence is a thin sheet with a layer of favorable sediments beneath it and above the thick diabase sheet below.[2] It is possible that the new Rossville copper occurrence represents "leakage" from a Cornwall-type deposit.

Diamond drill core intercepting copper mineralization in the same roadcut has been offered to the Survey. When our facilities permit, this core will be split, logged, assayed, and reported on in a future issue of *Pennsylvania Geology*. The outcrop has now been backfilled and seeded but many specimens were collected by the amateur mineralogists of York County. At this time, specimens may no longer be collected.

[1] Rose, A. W. (1970) Atlas of Pennsylvania's Mineral Resources, Pt. 3, *Metal Mines and Occurrences in Pennsylvania*, Pa. Geol. Survey, 4th ser., Bull. M50, 14 p.

[2] Smith, II, R. C. (1973) *Geochemistry of Triassic Diabase in Southeastern Pennsylvania*, unpublished Ph.D. thesis, The Pennsylvania State University.

EARTHQUAKE IN LANCASTER COUNTY

At 10:01 p.m. Thursday, December 7th, residents in the northern part of Lancaster County were startled by an earthquake that registered 2.9 (Richter scale) on the seismograph at The Pennsylvania State University.

This relatively minor quake sent tremors across a 20-mile swath extending from Adamstown to Manheim Township, in Lancaster County. The "Ephrata Review" reported many Ephrata residents thought their furnaces had exploded or that the disturbance was caused by a jet's sonic "boom".

The epicenter of the quake, according to Dr. B. F. Howell, Jr., professor of geophysics at The Pennsylvania State University, was located somewhere between Lancaster and Harrisburg.

Earthquakes are not new to this area. On January 7th, 1954, in the nearby community of Sinking Spring (Berks County) an earthquake caused minor damage in the west section of the town. Furniture was upset and dishes and bottles tumbled from their shelves.

Then on May 12th, 1964, a shock lasting less than one minute occurred in the vicinity of Cornwall. The epicenter of this quake was reported to be at Mastersonville, Lancaster County. This earthquake, with a registered magnitude of 3 to 4 (Richter), rattled windows and shook dishes.

Earthquakes have been reported in southeastern Pennsylvania since 1727. However, little is actually known about their origin. Are these quakes of "deep" or "shallow" origin? Are they related to near-surface or deep earth adjustments? Are they the result of a mine collapse or a limestone cave collapse? Records from three or more seismograph stations that have recorded these shocks should be studied in conjunction with known surface geology. Definite answers to these and related questions could have a very practical application.

Alan R. Geyer

1972 FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS MEETING BEDFORD, PENNSYLVANIA

Approximately 160 geologists from Pennsylvania and surrounding states, attended the 1972 Annual Field Conference of Pennsylvania Geologists. While most attendees were from Pennsylvania, Virginia, West Virginia, Ohio, New York, Maryland, Delaware, Washington, D. C., we had geologists come from Connecticut, Rhode Island, North Carolina, Colorado, Texas, Tennessee, and two geologists, visiting the U. S. National Museum, from Poland and Czechoslovakia.

The trip was very ably lead by John Dennison of the University of North Carolina, assisted by W. DeWitt, U. S. Geological Survey, Jim Head, Bellcom, Inc., Ken Hasson, East Tennessee State University, and Don Hoskins of the Pennsylvania Survey.

Most of the stops were at localities along the Alleghany Front in Maryland and West Virginia and the first day was marked by considerable rain. The second day, Saturday, improved very much and visits were made to the Cumberland Cement and Supply Company quarry at Corriganville. Here the attendees had the opportunity to examine an excellent exposure of limestones and their included fossils (Figure A and B).

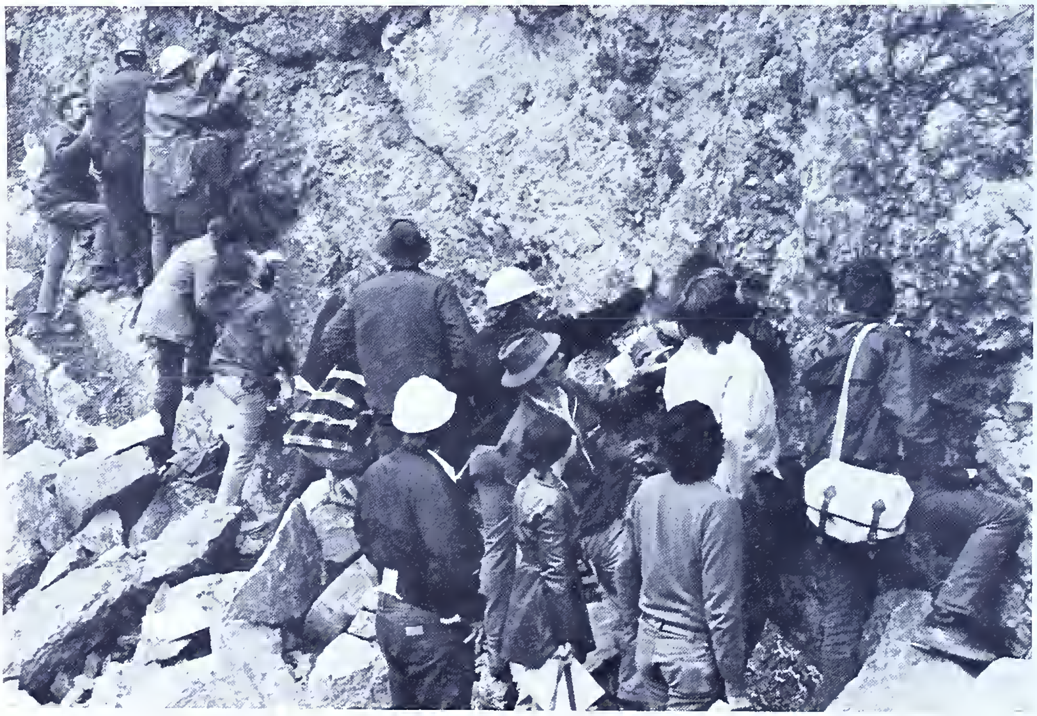


Figure A — Field trip members examine *Stromatopora* exposed on vertical face of Corriganville Quarry.

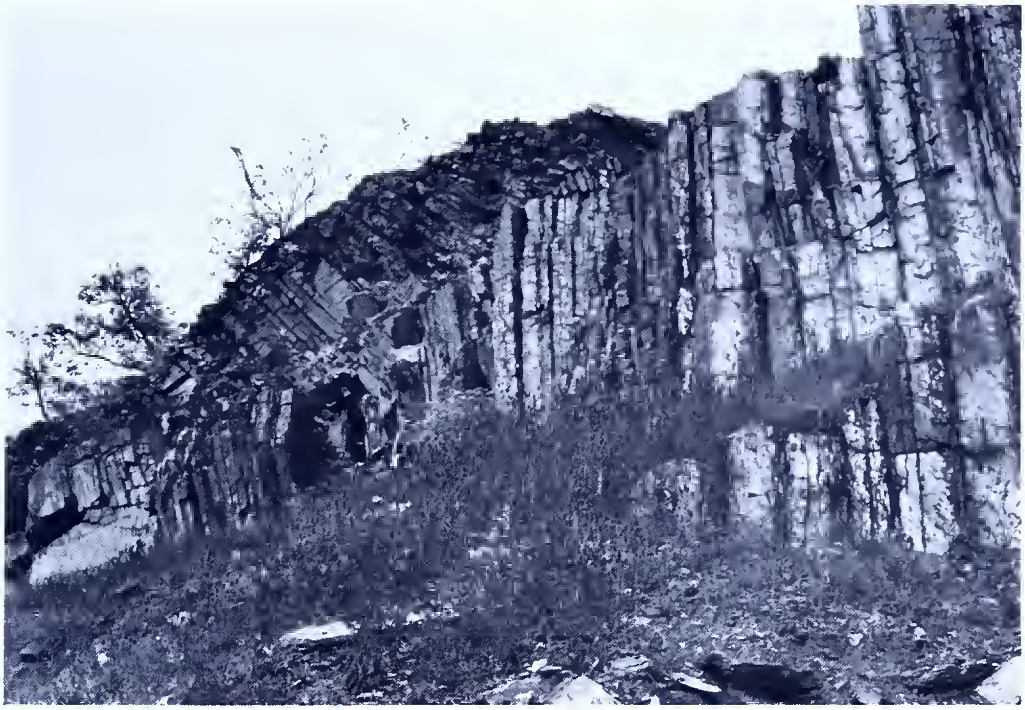


Figure B – Vertical dipping strata with downslope creep at west end of Corriganville Quarry.

Guidebooks for this trip, the 1971 trip to Northeastern Pennsylvania, and the 1970 trip to Eastern Maryland are available for $2.50 from Field Conference of Pennsylvania Geologists, c/o Pennsylvania Geological Survey, Department of Environmental Resources, P.O. Box 1467, Harrisburg, Pa., 17120. Please make check payable to the Field Conference of Pennsylvania Geologists.

1973's trip is planned to be in the Central Pennsylvania area in the folded belt area from Harrisburg to Sunbury.

NEED FOR GUIDEBOOKS

The Pennsylvania Geological Survey, which holds the files and records for the Field Conference of Pennsylvania Geologists, would like to obtain copies of all of the former guidebooks. All of the original copies of guidebooks dating to the beginning of the Field Conference were heavily damaged in the flood. We would appreciate gifts of guidebooks to keep as records for the Field Conference. Guidebooks of recent years will be reprinted as we can afford it.

PENNSYLVANIA MINERAL PRODUCTION UP

In 1972 value of mineral production in Pennsylvania was up to $1.2 billion, a rise of about 5 percent over the previous year. Coal, oil, and gas accounted for 68 percent of the total mineral value. The counties which led in mineral production value were Washington, Greene, Indiana, Armstrong, Cambria, Northampton, and Schuylkill.

Production increases in Pennsylvania were registered for bituminous coal, cement, lime, natural gas, and clay. Tropical storm Agnes was responsible for curtailing production at many mines and quarries due to high water and flooding. The anthracite mines were particularly hard hit and production dropped to 7.1 million tons. Production from Pennsylvania's only zinc mine dropped 35 percent due to Agnes and the storm was responsible for the early, final shutdown of the 230 year old Cornwall iron mine.

TOPOGRAPHIC MAPPING IN PENNSYLVANIA

The topographic mapping program in Pennsylvania is being conducted cooperatively by the Pennsylvania Geological Survey and the United States Geological Survey.

The adjoining map shows the progress to date in preparation of up-to-date 7.5 minute quadrangle (1 inch = 2,000 feet) topographic maps for Pennsylvania.

During calender 1972 an additional 190 quadrangle maps were published by the U. S. Geological Survey. A detailed index to these and prior published maps is available free from:

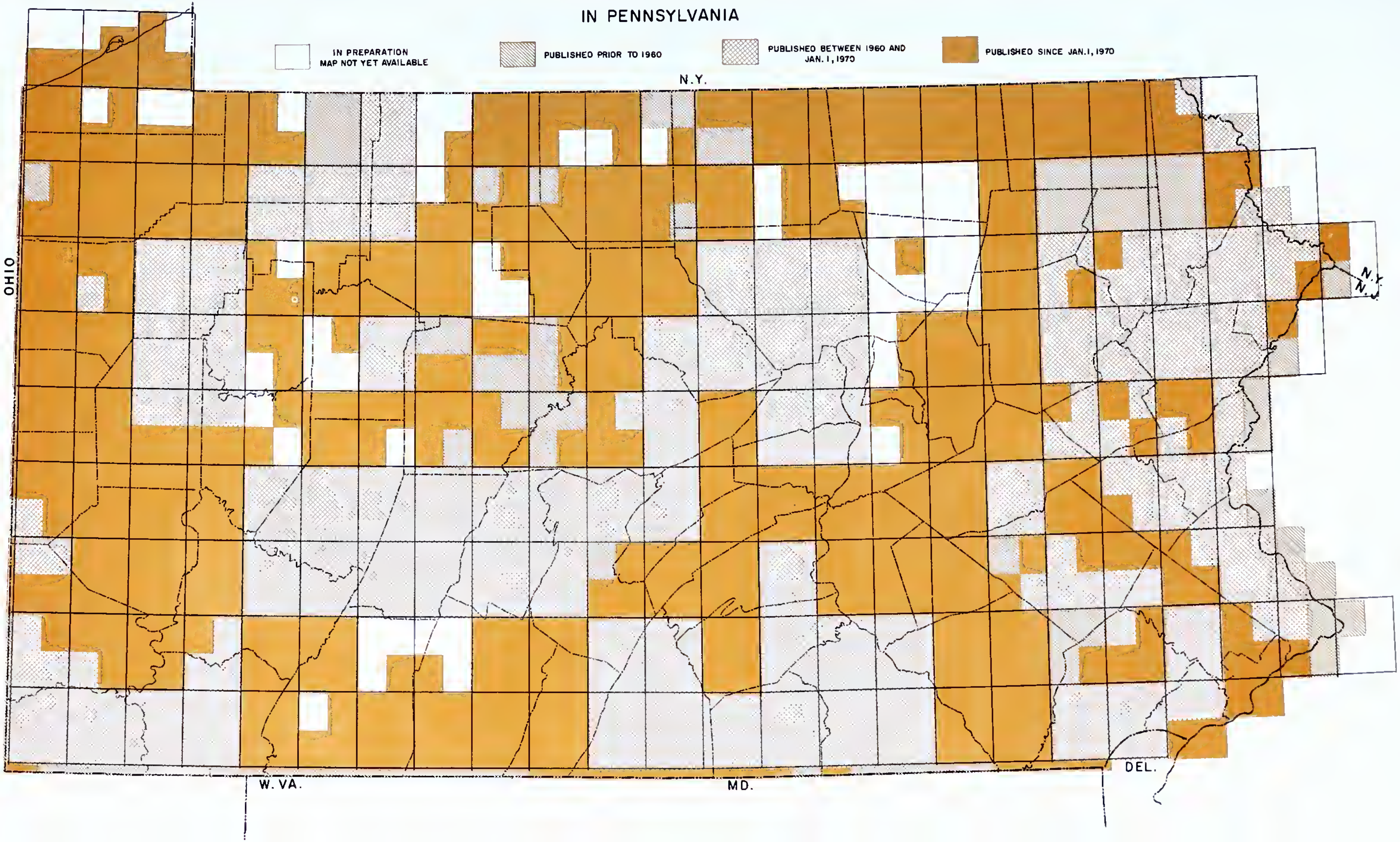
Pennsylvania Geological Survey
Dept. of Environmental Resources
Main Capitol Annex
Harrisburg, Pa. 17120

Washington Distribution Section
U. S. Geological Survey
1200 South Eads Street
Arlington, Va. 22202

Topographic maps may be purchased for $0.75 each from the Washington Distribution Section as listed above. On such orders, customers should state the name of the map as well as the type of map desired and are urged to use order blanks supplied with the Index to Topographic Mapping in Pennsylvania mentioned above. Orders must be accompanied by cash, check, or money order in the exact amount. Stamps will not be accepted as payment.

At slightly higher costs, maps may be purchased across the counter at agents in Pennsylvania listed on the detailed index.

STATUS OF 7½ MINUTE (1"=2000') TOPOGRAPHIC MAPPING IN PENNSYLVANIA



SATELLITE TO EYE RESOURCES AND POLLUTION

Scientists from the Pennsylvania Department of Environmental Resources want to turn a satellite into a new environmental watchdog system. Mr. Orval H. Minney, Director of the Office of Planning and Research, John Fedko, departmental computer expert, and William G. McGlade, geologist with the Bureau of Topographic and Geologic Survey, have requested NASA to use the presently flying Earth Resources Technology Satellite (ERTS-A) in the Pennsylvania program, as well as the next satellite (ERTS-B) which is now being planned.

The result may be information never before available on air and water resources pollution, mineral resource extraction, forest and crop diseases, geological descriptions and processes, and regional land uses in Pennsylvania.

If NASA approves the plan, Pennsylvania will be the first state to draw most of an environmental satellite's potential uses into one program. Under this plan the satellite would be used to monitor water quality, strip mining and reclamation, agriculture, forestry, and regional land management. Also, it is possible the satellite will prove useful as a tool for the exploration of new mineral deposits and ground water and in the detection of some geologic hazards.

Satellites ERTS-A and ERTS-B are able to pick out individual water pollution episodes, but will be used mainly to determine subtle, long range changes in water quality which equipment now in use fails to detect. It is hoped that the satellite information combined with a sophisticated computer system can help enforce and satisfy Pennsylvania's environmental regulations and provide the technology necessary for feasible and meaningful planning for the Commonwealth of Pennsylvania.

U.S. LOSES 491 MILLION TONS OF SEDIMENT YEARLY TO OCEANS

Every day 1.3 million tons of sediment are carried into the ocean by rivers draining the conterminous 48 states of the U. S. according to the U. S. Geological Survey. This totals 491 million tons a year, of which 245 million tons is carried into the ocean by the Mississippi River alone. While the Gulf receives a total of 1.03 million tons of sediment daily, the Atlantic Ocean receives 38.9 thousand tons and the Pacific Ocean receives about 271.4 thousand tons daily from the U. S.

Along the east coast, the Susquehanna River carries 1.9 million tons per year into the ocean, compared to 749 thousand tons by the Delaware River, and 786 thousand tons by the Potomac River.

SURVEY ANNOUNCEMENTS

BRODHEADSVILLE AREA GEOLOGIC MAPS ON OPEN FILE

The Pennsylvania Geological Survey announces that it is placing on open file bedrock and surficial geologic and fracture trace maps of the Brodheadsville 7½-minute Quadrangle, southern Monroe County which have been completed by Thomas M. Berg, staff geologist. This is one of several quadrangles currently being geologically mapped in northeastern Pennsylvania.

The bedrock map shows the distribution of the rock formations and their subdivisions in this area. Structural data displayed on the map include bedding, cleavage, and joint attitudes. Four geologic cross-sections accompany the bedrock map.

The surficial geologic map shows in considerable detail, the extent of glacial, periglacial, and alluvial deposits. Of particular interest is the distribution of the glacial "terminal" moraine and extensive deposits frequently called "chipstone". In all, nineteen surficial units have been mapped.

Final publication of full-color maps and complete text for the Brodheadsville area is expected in early 1974. To meet the immediate needs of residents, developers, and planners in this area, the Brodheadsville geologic maps are on open file and available at the following office:

Pennsylvania Geological Survey
Department of Environmental Resources
Commonwealth of Pennsylvania
Harrisburg, Pennsylvania 17120

TOPOGRAPHIC MAPS AVAILABLE

We are pleased to offer free topographic maps of the Delaware Water Gap and the Orbisonia quadrangles of 1936 and 1939 respectively. These discontinued 15-minute maps (scale 1 inch to the mile) are available singly of in reasonable quantities to interested persons or schools. Aside from local and historical interest, the maps should be useful for various topographic map exercises. The Delaware Water Gap quadrangle also carries the geologic description of the Gap on the reverse side.

These maps were made available to us by the U. S. Geological Survey. Originally, we received thousands of other maps, but regretably they were destroyed in the June flood. These two batches of maps also went through the flood but were saved and dried out in reasonably good condition.

Send your request to Arthur A. Socolow, Director, Pennsylvania Geological Survey, Department of Environmental Resources, Harrisburg, Pa., 17120. Be sure to indicate the quantity and quadrangle which you desire.

EARTH SCIENCE TEACHERS' CORNER

environmental impact of electrical generation: nuclear and conventional

The Pennsylvania Department of Education has developed a minicourse which attempts to present a balanced, unbiased study of the environmental benefit-to-risk ratio associated with the generation of electrical energy by either conventional or nuclear means. This short course, titled "The Environmental Impact of Electrical Generation: Nuclear and Conventional," is now in its final developmental stages following more than a year of efforts by a committee composed of nuclear engineers, members of the Sierra Club, representatives of public utilities, classroom teachers, health physicists, geologists from the Pennsylvania Geological Survey, and a physician specializing in nuclear medicine, all under the direction of the Division of Science and Mathematics of the Pennsylvania Department of Education.

The course text, teacher's manual, and evaluative materials have been field-tested in several Pennsylvania high schools and are now being revised as a result of this trial program.

Teachers who wish to receive copies of this minicourse upon its completion should contact John J. McDermott, Director, The Environmental Impact Project, Pennsylvania Department of Education, P. O. Box 911, Harrisburg, Pa. 17126.

flash-new earth & space science teachers guide released.......

Mr. William H. Bolles, Science Education Adviser for the Bureau of Curriculum Services in the Department of Education has just announced the release of "A Guide for Secondary Teachers EARTH AND SPACE SCIENCE". Copies of the guide will be distributed automatically to every Pennsylvania secondary school principal, both public and private. Any school district desiring additional copies may purchase them from the Division of Publication, Pennsylvania Department of Education.

A unique feature of the guide is the attempt made to indicate the relevance to man of the material being studied. All too often a science course is taught without mention of how the material can and is being used today by man. It is hoped that this guide will suggest some additional activities and approaches which will make it a useful additional reference for teachers as they explore the realm of the earth sciences.

PETROLEUM IN PENNSYLVANIA

Petroleum exploration and development increased in the Commonwealth during 1972 over that of 1971. This was primarily due to the need for crude oil and natural gas in these days of short supply and increase in demand. The total number of wells drilled was 956 for 1972 compared with 701 wells in 1971. Of these 956 wells, 518 were oil wells, 297 gas, 16 oil and gas, 70 dry, and 55 service, compared with those in 1971 of 390 oil, 203 gas, 48 dry, and 60 service.

Exploratory drilling has increased significantly during the latter part of 1972. The major and independent oil and gas companies who have leased millions of acres in the Commonwealth over the past two years have had time to evaluate some of the leased acreage and commenced exploratory drilling. This is very evident for during December, 1972 there were 20 deep wildcat wells, some of which had just been completed, were drilling, or the locations had just been staked. Some of the interesting ones consist of 1) a Gatesburg test in Erie County which had been plugged back and the operator is testing the Medina gas, 2) a Tuscarora test in Tioga County with a projected depth of 10,500 feet whose drilling depth has passed the halfway mark, 3) a Cambrian test also in Tioga County with a projected depth of 15,300 whose location has been staked, and 4) a Cambrian test in Warren County with a projected depth of 11,000 feet where the rotary rig is being moved in. These wells will be watched closely by all operators who have acreage in the area.

The wellhead price of both natural gas and crude oil have been increased. This is another inducement for exploratory drilling to find new reserves. The current wellhead price for all new natural gas is 45 cents per thousand cubic feet which is about 15 cents higher than a year ago. Other factors can come into play which can raise it above the 45 cent level. Effective December 1, 1972 there was an increase in the price of Pennsylvania grade crude oil of 60 cents a barrel. A 25 cent increase on May 1, 1971 raised the price per barrel in the Bradford District to $4.88, in the Middle District to $4.60 and the Southwestern District to $4.17. The current increase raised the price to $5.48, $5.20 and $4.77 respectively. The Corning grade crude in Erie and Crawford Counties now sells for $3.82 per barrel.

Some operators previous to the 60 cent raise had entered into a contract with a refiner to furnish them with all their new oil that they produced for the next 3 years and the refiner would pay them 60 cents a barrel for the new oil for one year. Operators whose contracts are still in force receive an additional 60 cents per barrel for new oil making the Middle District price of $5.80 per barrel. Some operators in certain areas haul their oil to the refiner. This of course, is an additional cost to the operators, but they are given an additional 40 cents a barrel.

The basic Bradford District price of $5.48 per barrel is the highest it has been since 1920 when a barrel of crude was worth $5.97. The next highest price prior to 1920 was 1869 when crude oil was selling at $5.64 a barrel.

Although the current increase is confined to specialty crudes in a small area isolated from major producing regions and affects less than 1% of the country's 9.5 million barrel per day crude production, to the producers of Pennsylvania grade crude oil it means new life and a chance to find new reserves. To the oil industry it means the continued production of one of the best crude oils that has been found.

William S. Lytle

THE EARTH AND HUMAN AFFAIRS

Books written by committees usually do not turn out to be much more than a conglomeration of the different ideas and styles of the separate committee members stuck together with a bit of compromise. Not so with the new book "The Earth and Human Affairs" issued by the Committee on Geological Sciences of the National Research Council - National Academy of Science. The work of making this report read like a book was done by Léo Laporte and he has done a very commendable job. The book reads well and easily.

The committee work and writing was done to make "new developments in and potential applications of the geological sciences . . . known to the public, the Congress and the executive" because each has the need to know and the need to influence the applications of geology to human affairs. This book can and should be read and used by laymen to intelligently evaluate proposals by government and business where geology is impinging on human affairs.

The book does not play down any of the problems of our environment, the energy and mineral needs of the future. It also carefully points out the consequences and implication of our part in changing the land and in the use and misuse of land.

"The geologic record of ancient life provides no evidence that mankind is destined to survive forever on this planet. Indeed, all the evidence is to the contrary, for many more species have been extinct than have survived. Unlike the species that have gone before us, however, we possess the knowledge and capacity to learn to adapt to the finite living space, materials and enemies of the earth well enough to postpone or possibly prevent our own ultimate extinction."

I highly recommend that all people who are concerned with the conservation of our environment and mankind read this book. It requires no detailed expertise in geology and can be read in a few hours. You will be amply rewarded by this effort.

"The Earth and Human Affairs" is available as a paperback for $1.95 from Harper and Row, Publishers.

Donald M. Hoskins
Assistant State Geologist

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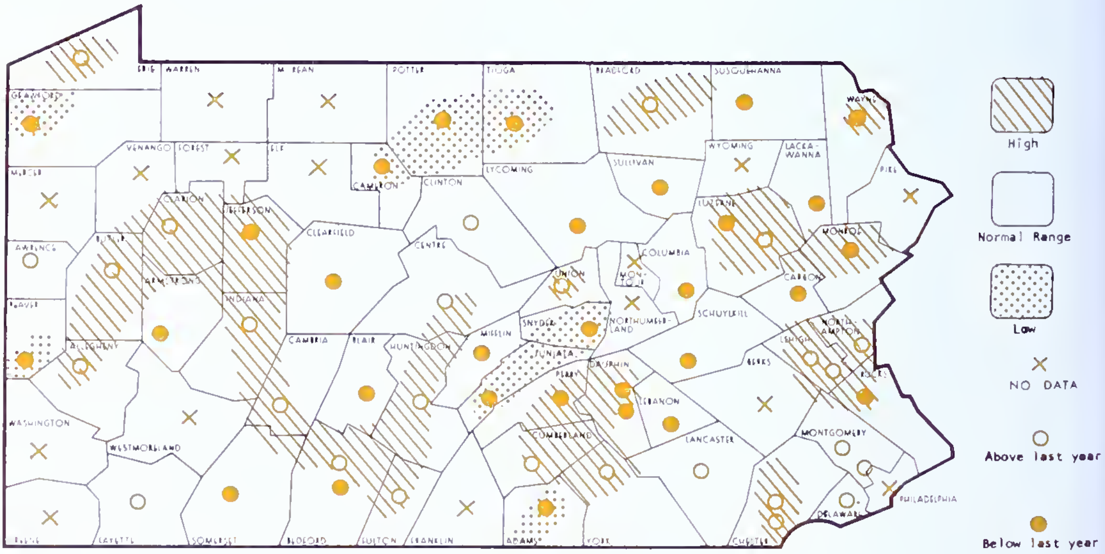
JANUARY 1973
GROUND-WATER LEVELS



PENNSYLVANIA GEOLOGY

THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 4/1

COMMONWEALTH OF PENNSYLVANIA
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DEPARTMENT OF ENVIRONMENTAL RESOURCES
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TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER – A landslide in Luzerne County due to a poorly designed stream relocation. Too often the geologic factors are overlooked in planning such projects.

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FEBRUARY 1973

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

HOLES IN THE GROUND---HIDDEN ASSETS

In recent years we have had a number of inquiries which suggest that a hole in the ground may be an asset. First we were approached if we knew of any dry, abandoned mines which could be converted into safe, records storage centers. Such adaptations already exist in other parts of the country.

Then there was the mushroom grower who came seeking guidance to abandoned mines as ideal sites to expand Pennsylvania's mushroom industry. Mines and caves have been adapted for mushrooms in many parts of the world.

At the recent AIME meeting a paper was presented on the merits of utilizing mines under certain favorable conditions as inexpensive reservoirs for large quantities of potable water. Similarly, if properly sealed, such mines could serve as natural gas storage reservoirs for an industry that needs storage capacity to cope with peak demands.

A year or so ago, a particularly novel idea was put forth to us, whereby a huge cavity would be excavated in bedrock, beneath one of our major cities in order to facilitate a pump-storage type of electric generating plant. The principle would be to let river water drop down into the deep void, moving past electric generators during peak electric demand. Then, during off-hours when demand was low, the water in the underground would be pumped out by surplus electricity. This is a reverse of the usual pump-storage facilities around the country where surface reservoirs are created on high ground and the water is pumped uphill during low demand. The subsurface reservoir has the advantages of (1) being located where needed, (2) better safeguards from pollution, and (3) much less environmental impact than a surface reservoir. Furthermore the rock obtained from the excavation could probably be sold to offset some of the excavating cost.

With surface mining and quarrying operations being subjected to more and more environmental restrictions and higher operating costs, it would seem that there may be a real future in having those operations go underground. Our industrial society needs the continued availability of the raw minerals being produced. Going underground would provide those minerals, with minimal environmental impact, and with subsurface voids that are becoming very marketable.

Once there was the anecdote about the oil well that was drilled and proved to be a dry hole. Along came an interprising young man who bought the well hole, cut it up, and sold the pieces for post holes. Maybe that idea is not so far fetched. There is a use for holes in the ground.

Arthur A. Socolow

LANDSLIDES: AN EARLY SPRING HAZARD
OR
THE CREEP THAT WOULDN'T SLOW DOWN

A potential problem exists along many of the hillsides and road cuts of Pennsylvania this spring. The unusually high water tables, especially in central Pennsylvania where 1972 was a record year for rainfall, and the lateness of the ground frost have brought many of the soils and weathered rock material to the point of saturation. After the spring thaw and rains arrive, perhaps all of this unconsolidated material will be saturated. This will be the time to expect three common types of landslides.

Along bedrock road cuts debris or rock slides will tend to occur. These result from soil mositure entering the fractures and joints of the rock, especially near the upper edge of the cut. As this water freezes, it expands, enlarging the fractures a small amount. If a thaw occurs the ice will melt and water will refill these same cracks. Another drop in temperature will freeze the water again and force the fractures open further. This cyclic freezing and thawing will occur throughout the winter until, during some thaw period, the rock and soil material sloughs off into the road cut. An examination of the top of road cuts will frequently disclose these expanded joints before sliding takes place.

Engineers and geologists have long known that the internal strength of unconsolidated material diminishes greatly as its water content increases. When saturated the material becomes unstable to varying degrees. This is the basic cause of the two other common types of landslides.

Everyone has seen lobes of mud moving slowly down steep embankments. These mud flows can sometimes be catastrophic, as in the Los Angeles area of California. This type of instability requires special conditions, usually a very heavy, prolonged rain on unprotected soil.

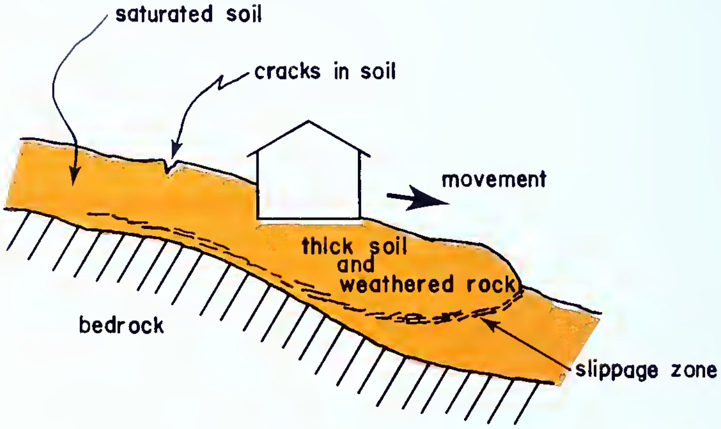


FIGURE I. FOUNDATION ON UNCONSOLIDATED MATERIAL

The other type of landslide, which is generally more gradual, is an accelerated form of soil creep. This can occur in fairly stable soils and on relatively shallow slopes if soil conditions are extremely wet and ground waters are high. Accelerated creep is more likely than the other types of slides to occur on slopes where houses or other structures have been built. Even this slower form of landslide can cause structural damage, from ceiling cracks and warped door jams to complete destruction of the foundation and downslope movement of the house. Early evidence for creep is the development of a sudden tilt to fence posts, trees, etc., the misalignment of fence and shrub rows, and sometimes the appearance of cracks along the slope where it steepens.

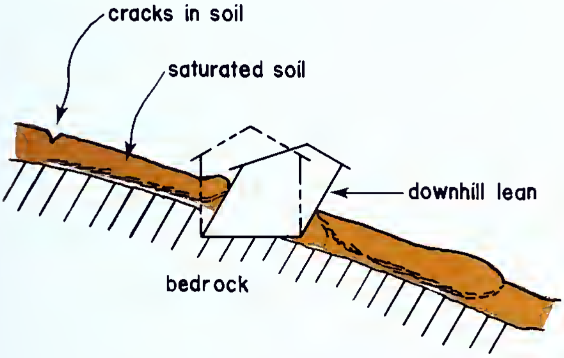


FIGURE 2. FOUNDATION ON BEDROCK

Several different situations involving accelerated creep can occur, but only two are illustrated in this article. Figure 1 shows a house on a moderate slope with its foundation on weathered rock material. The whole mass of soil has become saturated and is slowly moving downhill, including the house. Since these semi-fluid masses seldom move in a uniform manner, the foundation is also subjected to twisting forces. Figure 2 shows a house which is anchored in bedrock. In this case the soil mass is moving down on the house causing a downhill lean.

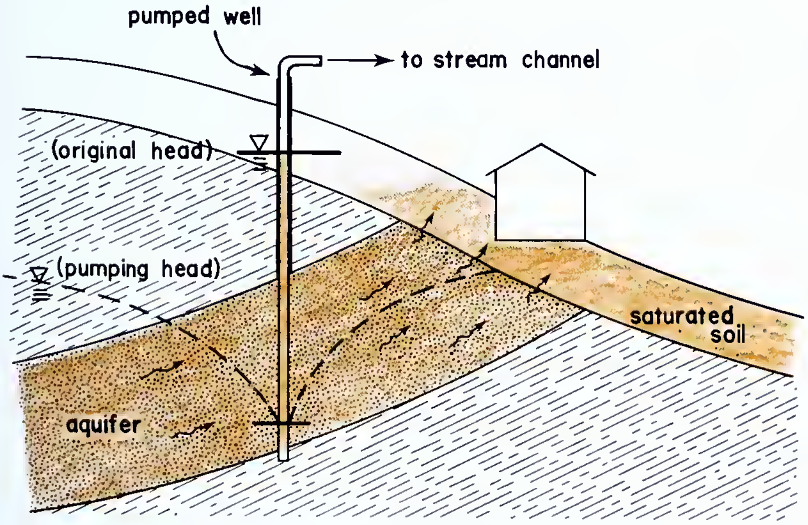


FIGURE 3. PUMPED WELL REDUCING THE AMOUNT OF DISCHARGE AND THE HEAD ON THAT DISCHARGE.

Since excess water is the cause of this particular sliding problem, the solution lies in removing this water. The soil mass will become more stable as the moisture content is reduced. If the discharge of ground water is creating the hazard as illustrated in Figure 3, wells can be drilled into the discharging aquifer and pumped to lower the water table (piezometric surface). If ground water does not play a significant role and the problem is caused chiefly by excess soil water, an array of auger holes can be drilled to intercept and drain the excess water. Figure 4 is a plan view of a hypothetical auger hole installation. In both cases care must be taken to pipe the collected water into a stream channel. Discharging this water into the soil below the house may create erosion or sliding problems for any structures below.

Slides are complicated functions of the specific soil properties of the site, the topography, the geologic structure, the rock type, the soil and ground-water systems, as well as recent climatic events. Identification of potential hazard areas and the solutions to specific sliding problems obviously requires the expert advice of the geologist or geological engineer. The design and operating procedure of an installation to prevent or stop a slide should also be handled by the geologist.

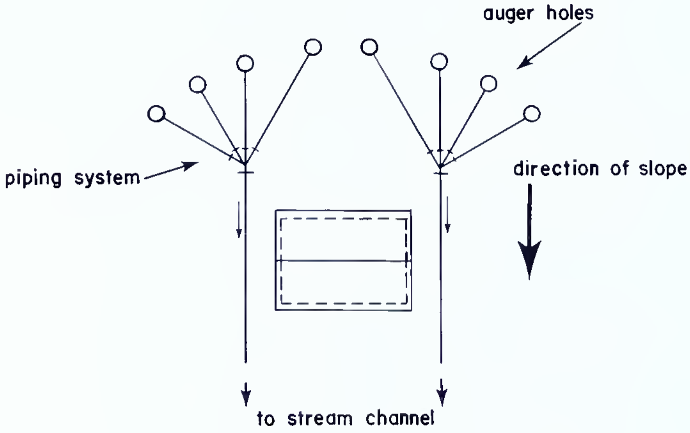


FIGURE 4. MAP VIEW OF AUGER HOLE ARRAY FOR DRAINING SOIL WATER

Even after water has been drained from the soil there is no guarantee that the hazard has been eliminated. Once a slide has established itself, a zone of weakness forms within the mass along which subsequent movements are more than likely to occur. In these cases preventative measures must be revived during succeeding wet seasons, or structural solutions found to stabilize the slope.

Evan T. Shuster

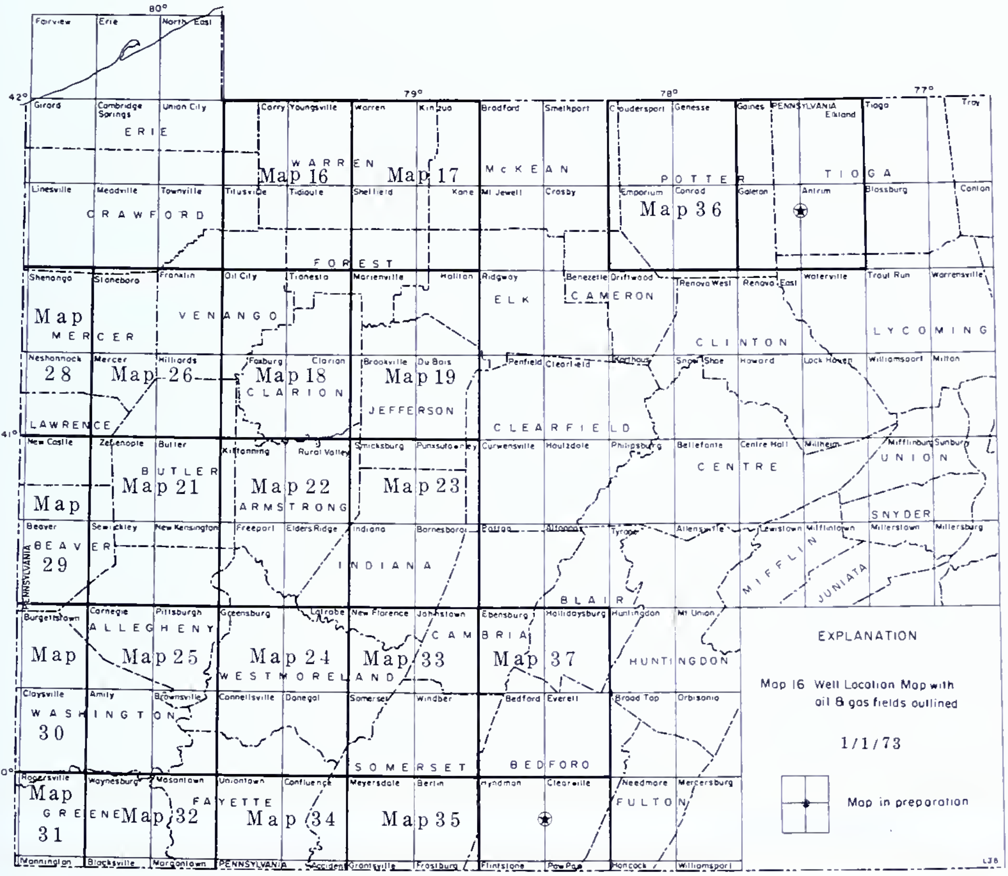
OIL AND GAS BASE MAPS AVAILABLE

Twenty base maps (see index map) showing locations of oil and gas wells and the outlines of the oil and gas fields are now available. Each base map encompasses four, 15-minute topographic quadrangles and is at the same scale of 1 inch equals a mile. A five-minute grid, quadrangle name, county boundaries, and major rivers and towns make up the background of the base map. All deep wells known and all shallow wells on record with the Pennsylvania Geological Survey are located, and the status (dry, oil producing, gas producting, etc.) are shown by symbol. Deep wells (Tully Formation or deeper) are differentiated and elevation and total depth are shown. Symbols indicate the availability of geophysical log and sample data on open file in the Survey's Oil and Gas Division office in Pittsburgh. An index map with the legend shows the outlines of oil and gas fields within the mapped area, thus indicating areas of extensive pre-1956 drilling. A listing of the field names is also included.

Paper prints of the base maps can be obtained by writing to the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125. Cost of each base map is $0.50, plus 6 percent state sales tax to Pennsylvania residents. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering please specify the map number.

A cross index of state permit numbers with quadrangle map numbers used on the base maps is available from the Pittsburgh Branch of the Pennsylvania Geological Survey, 401 Pittsburgh State Office Building, 300 Liberty Avenue, Pittsburgh, Pennsylvania 15222. This index is arranged by quadrangles. Please specify the quadrangle when requesting this listing. Base maps are updated every six months. Maps now available were updated as of 1/1/73.

William S. Lytle



We have moved again! Our new office address is Towne House Apartments, 660 Boas Street, Harrisburg 17102. Our mailing address is Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg 17120.

A NEW TRIASSIC COPPER OCCURRENCE AT ROSSVILLE, PA.

Last spring, an interesting occurrence of malachite and azurite on fractures in hornfels (a sediment baked by an igneous rock, in this case diabase) was reported to the Survey by Mr. Chester Griest of Dover. A short time later, Mr. Jay Linninger of Dillsburg donated some colorful specimens of this material.

One week before the flood, the occurrence, located 0.65 mile northwest of Rossville, York County, was visited by survey geologists B. J. O'Neill and B. C. Smith, II. At that time, six channel samples were collected through the mineralized beds. One of these samples, a mixture of red and brown oxides from a possible fault on the southwest side of the roadcut, was destroyed in the flood. The other five channel samples were carefully scrubbed piece by piece, rebagged, and sent out for Cu, Ag, and Au assays and Pb-Zn trace analyses. The following results were obtained:

Sample	Cu%	Au oz/ton	Ag oz/ton	Pb ppm	Zn ppm
1	2.0	.028	.26	150	195
3	1.1	$<.005$	.16	50	120
4	.38	.016	.19	60	120
5	.04	$<.005$	.43	25	55
6	.11	$<.005$	$<.01$	20	110

Sample 1 represented the main, 14"-thick, mineralized bed on the northeast side of the roadcut. Sample 3 represented the same 14"-thick bed on the southwest side. Sample 4 represented a 29"-thick interval directly above Sample 1. Sample 5 represented a 36"-thick altered greenish bed directly above Sample 4. Both O'Neill and Smith felt that this section might have contained more copper prior to weathering. Sample 6 represented a 40 ± 6"-thick section 30 feet northwest of Sample 5. The beds in the cut strike N31°E and dip 16°NW except near the possible fault close to the northwest end of the southwest side of the roadcut where the attitude is N52°E and 20°N. All observed mineralization is located in favorable beds.

Examination of polished sections with reflected light shows that the primary sulfides are either chalcopyrite or bornite, both successively rimmed by digenite and chalcocite. The bornite contains lamellae of chalcopyrite and traces of idaite. Silicate minerals observed by the authors include chrysocolla, epidote, garnet, actinolite, and stilbite.

Several small Cornwall-type iron-copper deposits are known to the southwest of this occurrence.[1] It has been suggested that the diabase to the north of the Rossville occurrence is a thin sheet with a layer of favorable sediments beneath it and above the thick diabase sheet below.[2] It is possible that the new Rossville copper occurrence represents "leakage" from a Cornwall-type deposit.

Diamond drill core intercepting copper mineralization in the same roadcut has been offered to the Survey. When our facilities permit, this core will be split, logged, assayed, and reported on in a future issue of *Pennsylvania Geology.* The outcrop has now been backfilled and seeded but many specimens were collected by the amateur mineralogists of York County. At this time, specimens may no longer be collected.

[1] Rose, A. W. (1970) Atlas of Pennsylvania's Mineral Resources, Pt. 3, *Metal Mines and Occurrences in Pennsylvania,* Pa. Geol. Survey, 4th ser., Bull. M50, 14 p.

[2] Smith, II, R. C. (1973) *Geochemistry of Triassic Diabase in Southeastern Pennsylvania,* unpublished Ph.D. thesis, The Pennsylvania State University.

EARTHQUAKE IN LANCASTER COUNTY

At 10:01 p.m. Thursday, December 7th, residents in the northern part of Lancaster County were startled by an earthquake that registered 2.9 (Richter scale) on the seismograph at The Pennsylvania State University.

This relatively minor quake sent tremors across a 20-mile swath extending from Adamstown to Manheim Township, in Lancaster County. The "Ephrata Review" reported many Ephrata residents thought their furnaces had exploded or that the disturbance was caused by a jet's sonic "boom".

The epicenter of the quake, according to Dr. B. F. Howell, Jr., professor of geophysics at The Pennsylvania State University, was located somewhere between Lancaster and Harrisburg.

Earthquakes are not new to this area. On January 7th, 1954, in the nearby community of Sinking Spring (Berks County) an earthquake caused minor damage in the west section of the town. Furniture was upset and dishes and bottles tumbled from their shelves.

Then on May 12th, 1964, a shock lasting less than one minute occurred in the vicinity of Cornwall. The epicenter of this quake was reported to be at Mastersonville, Lancaster County. This earthquake, with a registered magnitude of 3 to 4 (Richter), rattled windows and shook dishes.

Earthquakes have been reported in southeastern Pennsylvania since 1727. However, little is actually known about their origin. Are these quakes of "deep" or "shallow" origin? Are they related to near-surface or deep earth adjustments? Are they the result of a mine collapse or a limestone cave collapse? Records from three or more seismograph stations that have recorded these shocks should be studied in conjunction with known surface geology. Definite answers to these and related questions could have a very practical application.

Alan R. Geyer

1972 FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS MEETING BEDFORD, PENNSYLVANIA

Approximately 160 geologists from Pennsylvania and surrounding states, attended the 1972 Annual Field Conference of Pennsylvania Geologists. While most attendees were from Pennsylvania, Virginia, West Virginia, Ohio, New York, Maryland, Delaware, Washington, D. C., we had geologists come from Connecticut, Rhode Island, North Carolina, Colorado, Texas, Tennessee, and two geologists, visiting the U. S. National Museum, from Poland and Czechoslovakia.

The trip was very ably lead by John Dennison of the University of North Carolina, assisted by W. DeWitt, U. S. Geological Survey, Jim Head, Bellcom, Inc., Ken Hasson, East Tennessee State University, and Don Hoskins of the Pennsylvania Survey.

Most of the stops were at localities along the Alleghany Front in Maryland and West Virginia and the first day was marked by considerable rain. The second day, Saturday, improved very much and visits were made to the Cumberland Cement and Supply Company quarry at Corriganville. Here the attendees had the opportunity to examine an excellent exposure of limestones and their included fossils (Figure A and B).

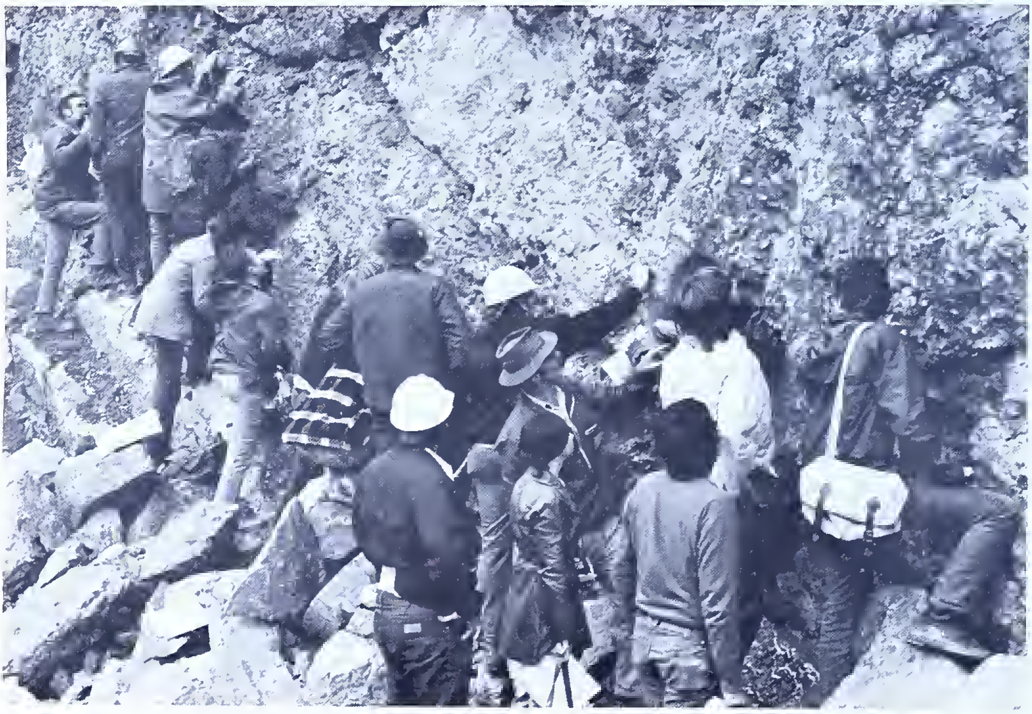


Figure A — Field trip members examine *Stromatopora* exposed on vertical face of Corriganville Quarry.

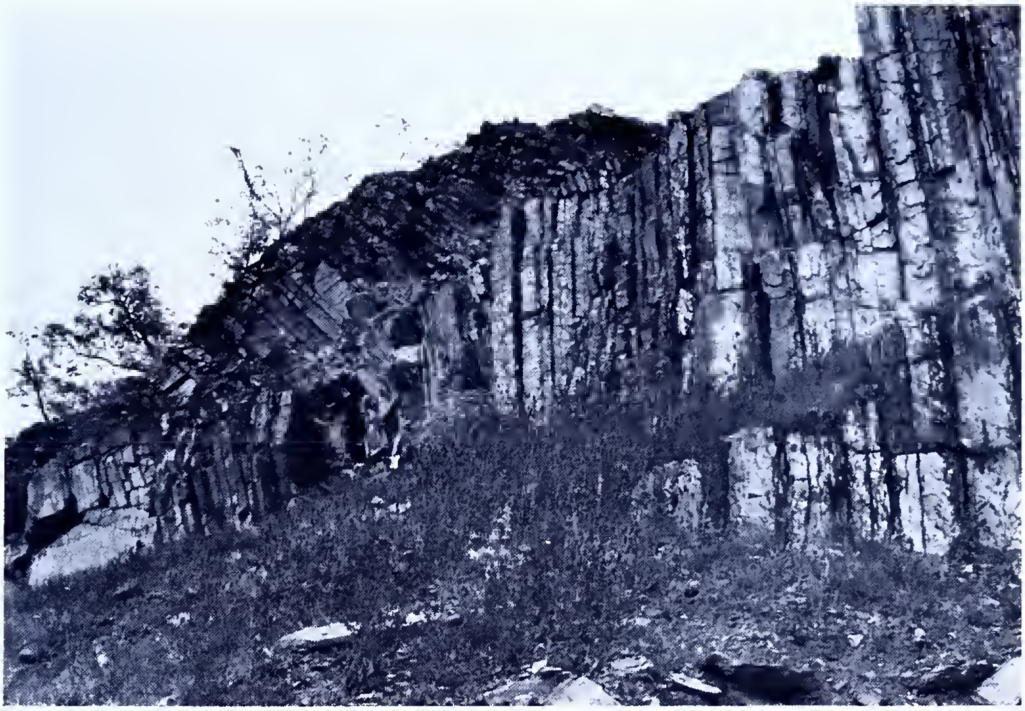


Figure B — Vertical dipping strata with downslope creep at west end of Corriganville Quarry.

Guidebooks for this trip, the 1971 trip to Northeastern Pennsylvania, and the 1970 trip to Eastern Maryland are available for $2.50 from Field Conference of Pennsylvania Geologists, c/o Pennsylvania Geological Survey, Department of Environmental Resources, P.O. Box 1467, Harrisburg, Pa., 17120. Please make check payable to the Field Conference of Pennsylvania Geologists.

1973's trip is planned to be in the Central Pennsylvania area in the folded belt area from Harrisburg to Sunbury.

NEED FOR GUIDEBOOKS

The Pennsylvania Geological Survey, which holds the files and records for the Field Conference of Pennsylvania Geologists, would like to obtain copies of all of the former guidebooks. All of the original copies of guidebooks dating to the beginning of the Field Conference were heavily damaged in the flood. We would appreciate gifts of guidebooks to keep as records for the Field Conference. Guidebooks of recent years will be reprinted as we can afford it.

PENNSYLVANIA MINERAL PRODUCTION UP

In 1972 value of mineral production in Pennsylvania was up to $1.2 billion, a rise of about 5 percent over the previous year. Coal, oil, and gas accounted for 68 percent of the total mineral value. The counties which led in mineral production value were Washington, Greene, Indiana, Armstrong, Cambria, Northampton, and Schuylkill.

Production increases in Pennsylvania were registered for bituminous coal, cement, lime, natural gas, and clay. Tropical storm Agnes was responsible for curtailing production at many mines and quarries due to high water and flooding. The anthracite mines were particularly hard hit and production dropped to 7.1 million tons. Production from Pennsylvania's only zinc mine dropped 35 percent due to Agnes and the storm was responsible for the early, final shutdown of the 230 year old Cornwall iron mine.

TOPOGRAPHIC MAPPING IN PENNSYLVANIA

The topographic mapping program in Pennsylvania is being conducted cooperatively by the Pennsylvania Geological Survey and the United States Geological Survey.

The adjoining map shows the progress to date in preparation of up-to-date 7.5 minute quadrangle (1 inch = 2,000 feet) topographic maps for Pennsylvania.

During calender 1972 an additional 190 quadrangle maps were published by the U. S. Geological Survey. A detailed index to these and prior published maps is available free from:

Pennsylvania Geological Survey
Dept. of Environmental Resources
Main Capitol Annex
Harrisburg, Pa. 17120

Washington Distribution Section
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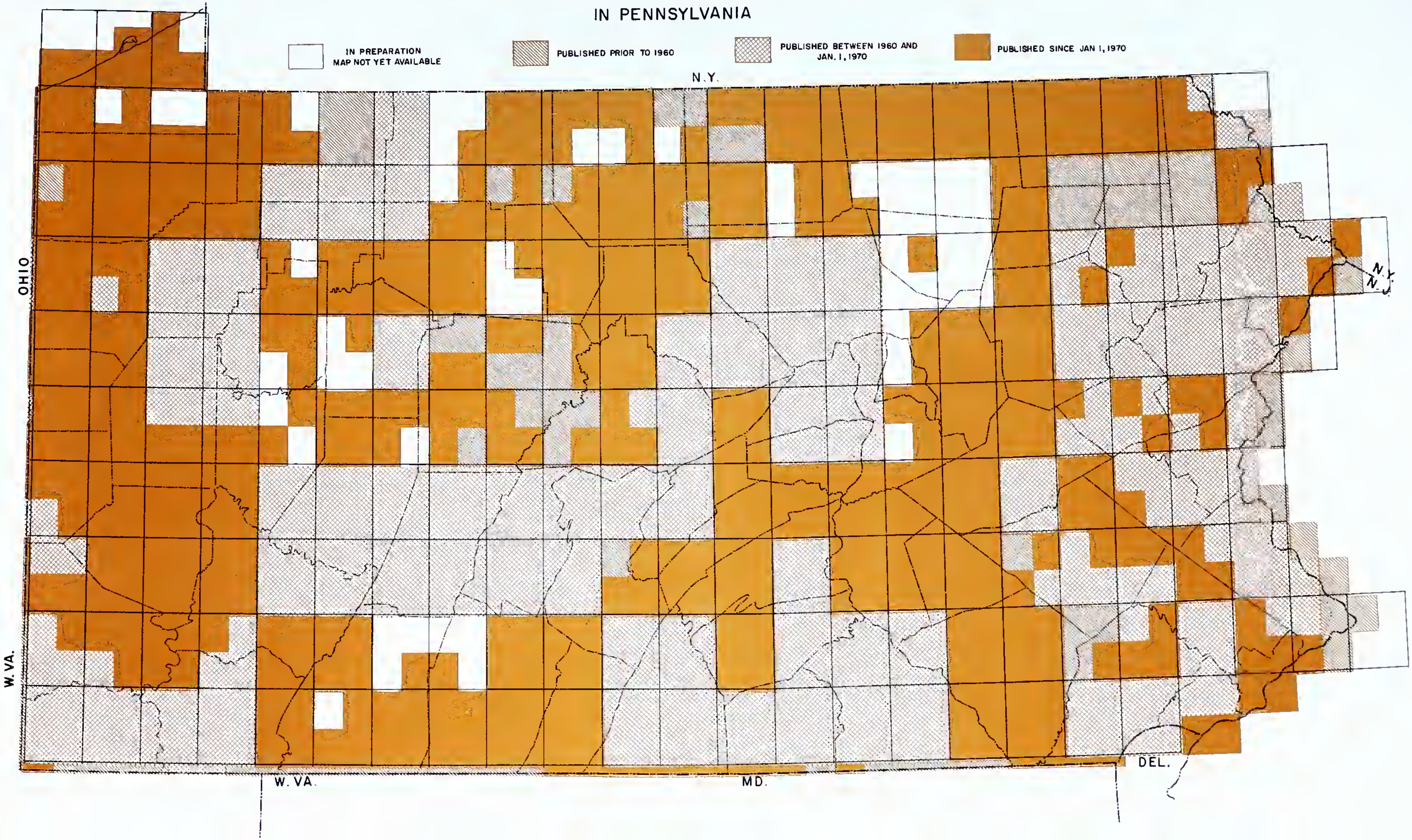
Topographic maps may be purchased for $0.75 each from the Washington Distribution Section as listed above. On such orders, customers should state the name of the map as well as the type of map desired and are urged to use order blanks supplied with the Index to Topographic Mapping in Pennsylvania mentioned above. Orders must be accompanied by cash, check, or money order in the exact amount. Stamps will not be accepted as payment.

At slightly higher costs, maps may be purchased across the counter at agents in Pennsylvania listed on the detailed index.

STATUS OF 7½ MINUTE (1"=2000') TOPOGRAPHIC MAPPING IN PENNSYLVANIA



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SATELLITE TO EYE RESOURCES AND POLLUTION

Scientists from the Pennsylvania Department of Environmental Resources want to turn a satellite into a new environmental watchdog system. Mr. Orval H. Minney, Director of the Office of Planning and Research, John Fedko, departmental computer expert, and William G. McGlade, geologist with the Bureau of Topographic and Geologic Survey, have requested NASA to use the presently flying Earth Resources Technology Satellite (ERTS-A) in the Pennsylvania program, as well as the next satellite (ERTS-B) which is now being planned.

The result may be information never before available on air and water resources pollution, mineral resource extraction, forest and crop diseases, geological descriptions and processes, and regional land uses in Pennsylvania.

If NASA approves the plan, Pennsylvania will be the first state to draw most of an environmental satellite's potential uses into one program. Under this plan the satellite would be used to monitor water quality, strip mining and reclamation, agriculture, forestry, and regional land management. Also, it is possible the satellite will prove useful as a tool for the exploration of new mineral deposits and ground water and in the detection of some geologic hazards.

Satellites ERTS-A and ERTS-B are able to pick out individual water pollution episodes, but will be used mainly to determine subtle, long range changes in water quality which equipment now in use fails to detect. It is hoped that the satellite information combined with a sophisticated computer system can help enforce and satisfy Pennsylvania's environmental regulations and provide the technology necessary for feasible and meaningful planning for the Commonwealth of Pennsylvania.

U.S. LOSES 491 MILLION TONS OF SEDIMENT YEARLY TO OCEANS

Every day 1.3 million tons of sediment are carried into the ocean by rivers draining the conterminous 48 states of the U.S. according to the U.S. Geological Survey. This totals 491 million tons a year, of which 245 million tons is carried into the ocean by the Mississippi River alone. While the Gulf receives a total of 1.03 million tons of sediment daily, the Atlantic Ocean receives 38.9 thousand tons and the Pacific Ocean receives about 271.4 thousand tons daily from the U. S.

Along the east coast, the Susquehanna River carries 1.9 million tons per year into the ocean, compared to 749 thousand tons by the Delaware River, and 786 thousand tons by the Potomac River.

SURVEY ANNOUNCEMENTS

BRODHEADSVILLE AREA GEOLOGIC MAPS ON OPEN FILE

The Pennsylvania Geological Survey announces that it is placing on open file bedrock and surficial geologic and fracture trace maps of the Brodheadsville 7½-minute Quadrangle, southern Monroe County which have been completed by Thomas M. Berg, staff geologist. This is one of several quadrangles currently being geologically mapped in northeastern Pennsylvania.

The bedrock map shows the distribution of the rock formations and their subdivisions in this area. Structural data displayed on the map include bedding, cleavage, and joint attitudes. Four geologic cross-sections accompany the bedrock map.

The surficial geologic map shows in considerable detail, the extent of glacial, periglacial, and alluvial deposits. Of particular interest is the distribution of the glacial "terminal" moraine and extensive deposits frequently called "chipstone". In all, nineteen surficial units have been mapped.

Final publication of full-color maps and complete text for the Brodheadsville area is expected in early 1974. To meet the immediate needs of residents, developers, and planners in this area, the Brodheadsville geologic maps are on open file and available at the following office:

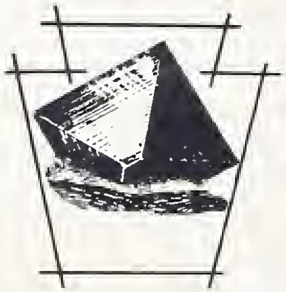
Pennsylvania Geological Survey
Department of Environmental Resources
Commonwealth of Pennsylvania
Harrisburg, Pennsylvania 17120

TOPOGRAPHIC MAPS AVAILABLE

We are pleased to offer free topographic maps of the Delaware Water Gap and the Orbisonia quadrangles of 1936 and 1939 respectively. These discontinued 15-minute maps (scale 1 inch to the mile) are available singly of in reasonable quantities to interested persons or schools. Aside from local and historical interest, the maps should be useful for various topographic map exercises. The Delaware Water Gap quadrangle also carries the geologic description of the Gap on the reverse side.

These maps were made available to us by the U. S. Geological Survey. Originally, we received thousands of other maps, but regretably they were destroyed in the June flood. These two batches of maps also went through the flood but were saved and dried out in reasonably good condition.

Send your request to Arthur A. Socolow, Director, Pennsylvania Geological Survey, Department of Environmental Resources, Harrisburg, Pa., 17120. Be sure to indicate the quantity and quadrangle which you desire.



EARTH SCIENCE TEACHERS' CORNER

environmental impact of electrical generation: nuclear and conventional

The Pennsylvania Department of Education has developed a minicourse which attempts to present a balanced, unbiased study of the environmental benefit-to-risk ratio associated with the generation of electrical energy by either conventional or nuclear means. This short course, titled "The Environmental Impact of Electrical Generation: Nuclear and Conventional," is now in its final developmental stages following more than a year of efforts by a committee composed of nuclear engineers, members of the Sierra Club, representatives of public utilities, classroom teachers, health physicists, geologists from the Pennsylvania Geological Survey, and a physician specializing in nuclear medicine, all under the direction of the Division of Science and Mathematics of the Pennsylvania Department of Education.

The course text, teacher's manual, and evaluative materials have been field-tested in several Pennsylvania high schools and are now being revised as a result of this trial program.

Teachers who wish to receive copies of this minicourse upon its completion should contact John J. McDermott, Director, The Environmental Impact Project, Pennsylvania Department of Education, P. O. Box 911, Harrisburg, Pa. 17126.

flash-new earth & space science teachers guide released.......

Mr. William H. Bolles, Science Education Adviser for the Bureau of Curriculum Services in the Department of Education has just announced the release of "A Guide for Secondary Teachers EARTH AND SPACE SCIENCE". Copies of the guide will be distributed automatically to every Pennsylvania secondary school principal, both public and private. Any school district desiring additional copies may purchase them from the Division of Publication, Pennsylvania Department of Education.

A unique feature of the guide is the attempt made to indicate the relevance to man of the material being studied. All too often a science course is taught without mention of how the material can and is being used today by man. It is hoped that this guide will suggest some additional activities and approaches which will make it a useful additional reference for teachers as they explore the realm of the earth sciences.

PETROLEUM IN PENNSYLVANIA

Petroleum exploration and development increased in the Commonwealth during 1972 over that of 1971. This was primarily due to the need for crude oil and natural gas in these days of short supply and increase in demand. The total number of wells drilled was 956 for 1972 compared with 701 wells in 1971. Of these 956 wells, 518 were oil wells, 297 gas, 16 oil and gas, 70 dry, and 55 service, compared with those in 1971 of 390 oil, 203 gas, 48 dry, and 60 service.

Exploratory drilling has increased significantly during the latter part of 1972. The major and independent oil and gas companies who have leased millions of acres in the Commonwealth over the past two years have had time to evaluate some of the leased acreage and commenced exploratory drilling. This is very evident for during December, 1972 there were 20 deep wildcat wells, some of which had just been completed, were drilling, or the locations had just been staked. Some of the interesting ones consist of 1) a Gatesburg test in Erie County which had been plugged back and the operator is testing the Medina gas, 2) a Tuscarora test in Tioga County with a projected depth of 10,500 feet whose drilling depth has passed the halfway mark, 3) a Cambrian test also in Tioga County with a projected depth of 15,300 whose location has been staked, and 4) a Cambrian test in Warren County with a projected depth of 11,000 feet where the rotary rig is being moved in. These wells will be watched closely by all operators who have acreage in the area.

The wellhead price of both natural gas and crude oil have been increased. This is another inducement for exploratory drilling to find new reserves. The current wellhead price for all new natural gas is 45 cents per thousand cubic feet which is about 15 cents higher than a year ago. Other factors can come into play which can raise it above the 45 cent level. Effective December 1, 1972 there was an increase in the price of Pennsylvania grade crude oil of 60 cents a barrel. A 25 cent increase on May 1, 1971 raised the price per barrel in the Bradford District to $4.88, in the Middle District to $4.60 and the Southwestern District to $4.17. The current increase raised the price to $5.48, $5.20 and $4.77 respectively. The Corning grade crude in Erie and Crawford Counties now sells for $3.82 per barrel.

Some operators previous to the 60 cent raise had entered into a contract with a refiner to furnish them with all their new oil that they produced for the next 3 years and the refiner would pay them 60 cents a barrel for the new oil for one year. Operators whose contracts are still in force receive an additional 60 cents per barrel for new oil making the Middle District price of $5.80 per barrel. Some operators in certain areas haul their oil to the refiner. This of course, is an additional cost to the operators, but they are given an additional 40 cents a barrel.

The basic Bradford District price of $5.48 per barrel is the highest it has been since 1920 when a barrel of crude was worth $5.97. The next highest price prior to 1920 was 1869 when crude oil was selling at $5.64 a barrel.

Although the current increase is confined to specialty crudes in a small area isolated from major producing regions and affects less than 1% of the country's 9.5 million barrel per day crude production, to the producers of Pennsylvania grade crude oil it means new life and a chance to find new reserves. To the oil industry it means the continued production of one of the best crude oils that has been found.

William S. Lytle

THE EARTH AND HUMAN AFFAIRS

Books written by committees usually do not turn out to be much more than a conglomeration of the different ideas and styles of the separate committee members stuck together with a bit of compromise. Not so with the new book "The Earth and Human Affairs" issued by the Committee on Geological Sciences of the National Research Council - National Academy of Science. The work of making this report read like a book was done by Léo Laporte and he has done a very commendable job. The book reads well and easily.

The committee work and writing was done to make "new developments in and potential applications of the geological sciences . . . known to the public, the Congress and the executive" because each has the need to know and the need to influence the applications of geology to human affairs. This book can and should be read and used by laymen to intelligently evaluate proposals by government and business where geology is impinging on human affairs.

The book does not play down any of the problems of our environment, the energy and mineral needs of the future. It also carefully points out the consequences and implication of our part in changing the land and in the use and misuse of land.

"The geologic record of ancient life provides no evidence that mankind is destined to survive forever on this planet. Indeed, all the evidence is to the contrary, for many more species have been extinct than have survived. Unlike the species that have gone before us, however, we possess the knowledge and capacity to learn to adapt to the finite living space, materials and enemies of the earth well enough to postpone or possibly prevent our own ultimate extinction."

I highly recommend that all people who are concerned with the conservation of our environment and mankind read this book. It requires no detailed expertise in geology and can be read in a few hours. You will be amply rewarded by this effort.

"The Earth and Human Affairs" is available as a paperback for $1.95 from Harper and Row, Publishers.

Donald M. Hoskins
Assistant State Geologist

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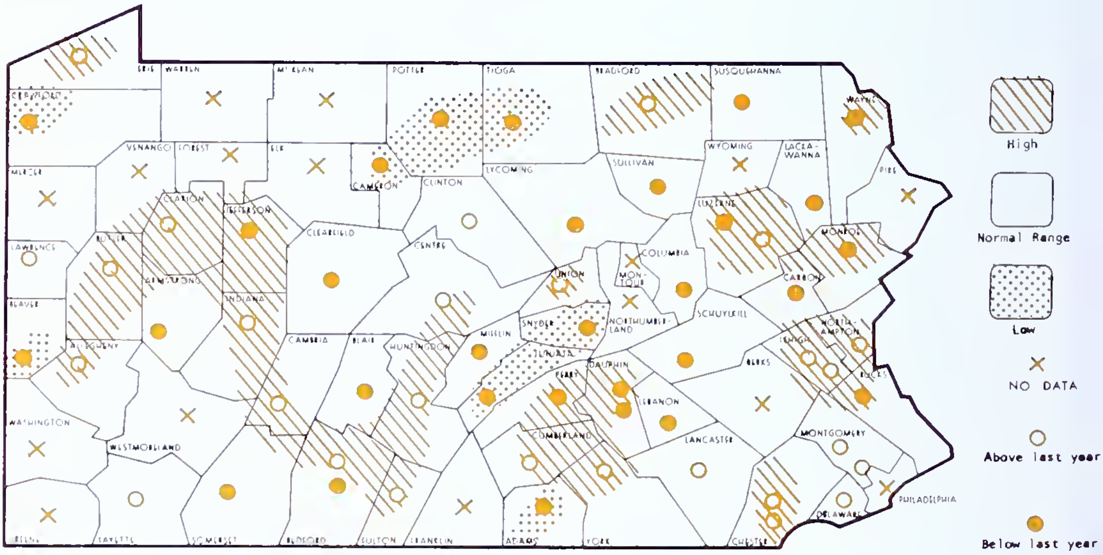

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THE PENNSYLVANIA GEOLOGICAL SURVEY

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TOPOGRAPHIC AND GEOLOGIC SURVEY
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ON THE COVER — "Steps" in Devonian Trimmers Rock sandstone formed by fractures perpendicular to the bedding. For scale, see meter stick standing next to large tree. Along Penn-Central RR on NE bank of Susquehanna River, SE of Larry Creek, 10 miles west of Williamsport. Photo by R. T. Faill.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

APRIL 1973

FROM THE DESK

OF THE

STATE GEOLOGIST . . .

GEOLOGY AND THE ENERGY CRISIS

Once again the subject of geology stands out as a prominent factor on the contemporary scene. Having already been identified with such noteworthy events as moon exploration, earthquake disasters, and environmental planning, geology now stands out in the key role of the energy crisis.

Whether we are concerned with the shortages of oil and gas, or the pollution from our high sulfur coal deposits, or the radiation problems of nuclear fueled reactors, in each instance we are dealing with a geologic mineral resource. And whatever the resolution of the problem is, be it by new oil and gas discoveries, or by coal gasification and liquification, or by oil shale and tar sand development, or by coal cleaning techniques, or geothermal energy development, the solutions for the energy crisis will entail geologic research and expertise.

Here in Pennsylvania where we face energy shortages as great as any in the nation, we of the Pennsylvania Geological Survey feel that the geological resources within our Commonwealth offer relief from the energy squeeze. Our recent Bulletin IC 72, The Coal Reserves of Pennsylvania, details the existence of over 20 billion tons of recoverable coal in Pennsylvania. Our Bulletin M 65, The Petroleum Industry and the Future Petroleum Province in Pennsylvania, spells out the potential for new oil and gas discoveries in areas and depths of Pennsylvania which have barely been tested to date.

The Pennsylvania Geological Survey has kept faith in the energy resources of our Commonwealth. Systematically, for over fifty years we have been mapping the distribution, thicknesses, and structures of our coal deposits. We have collected geologic data from thousands of our oil and gas wells so that we could interpret their significance with the aim of locating new oil and gas fields. It is fortunate that we had the foresight to begin the studies and data collection of our mineral fuel resources in years past. The accumulated wealth of knowledge is now paying off, as we are able to make a geological contribution to solving the energy problems of Pennsylvania. The results of our studies are all available through our extensive list of published geological reports.

Arthur A. Socolow

SINKHOLES - A CONSTANT PROBLEM

On Wednesday, February 7, 1973, an article appeared in the Harrisburg morning newspaper describing a sinkhole which has developed in a highway near Mechanicsburg, Cumberland County. On investigation it was found that the sinkhole described in the paper had been filled but that there was another similar problem in the same area. This second sinkhole reported that day had not been filled, and an augering crew was presently trying to determine the limits of the collapse.

An open excavation along Rt. 114 about 1500 feet south of the Mechanicsburg Borough line illustrates the local development of karst features beneath a soil cover. Bedrock exposed is the Rockdale Run Formation.

Removal of the soil left a series of limestone pinnacles. The long axis, or dimension, was aligned along the strike of the limestone, N64°E. The dip of the strata was 41° to the south. All of the pinnacles extended across the width of the cut. The cross-sectional shape of the pinnacle is asymmetrical. The south facing slope was at or slightly greater than the dip angle. The north facing slope was nearly vertical or slightly overhung. Depth to bedrock between the pinnacles increased toward the south (downhill) from 2 feet to a depth greater than 4 feet. The distance from

View of the open excavation looking south along Rt. 114. The tops of the limestone pinnacles can be seen.

The largest pinnacles at least 3½ feet high. The floor was not excavated to bedrock.

View looking to the SW along the trend of the pinnacles. Scale is a box of Polaroid film. Surface of rock on left is a bedding plane.

Sinkhole at base of ditch. Highway is at upper left.

pinnacle to pinnacle increased in the same direction, as did the soil cover on the tops of the pinnacles.

The reported sinkhole was in the bottom of a drainage ditch coming from the area of the excavation. The sinkhole tends toward the southwest (directly under Rt. 114) and has a pool of water at the bottom.

Looking down one of the auger holes. Note the rock ledge which is approx. 5 feet below ground surface. Opening extends beneath ledge. Road bed is directly above ledge.

The adjacent photograph is a shot into one of the auger holes which had broken into a cavity. The roof material here was about 6 inches thick. The material out of focus in the foreground is the ground surface. The light is shining on a bedrock ledge and the hole can be seen extending beneath it. The problem was probably caused by high ground waters or surface water in the ditch which washed the soil material from between bedrock pinnacles. The berm material along the edge of the road acted as an impermeable caprock. The cavity beneath this was formed by collapse as the deeper soil material was washed away.

This sinkhole problem demonstrates a situation which exists throughout the Cumberland Valley and the other limestone valleys in Pennsylvania. The drainage ditch diverts storm runoff from its natural drainage path on the southwest side of Rt. 114. The natural path had become a residential strip complete with basements, lawns and gardens. During periods of excessively high precipitation these homes were subjected to minor flooding. The ditch was dug to prevent this, which it did to some extent. However, it was the diverted runoff which created the sinkhole. Appropriate zoning could have prevented this incompatible interaction of land use and geology. Since this situation already exists, sinkhole development can be prevented by the construction of *lined* ditches or storm sewers which carry the water to the channels of permanent streams.

Evan T. Shuster

USE OF A GENERALIZED SLOPE MAP IN REGIONAL PLANNING

by

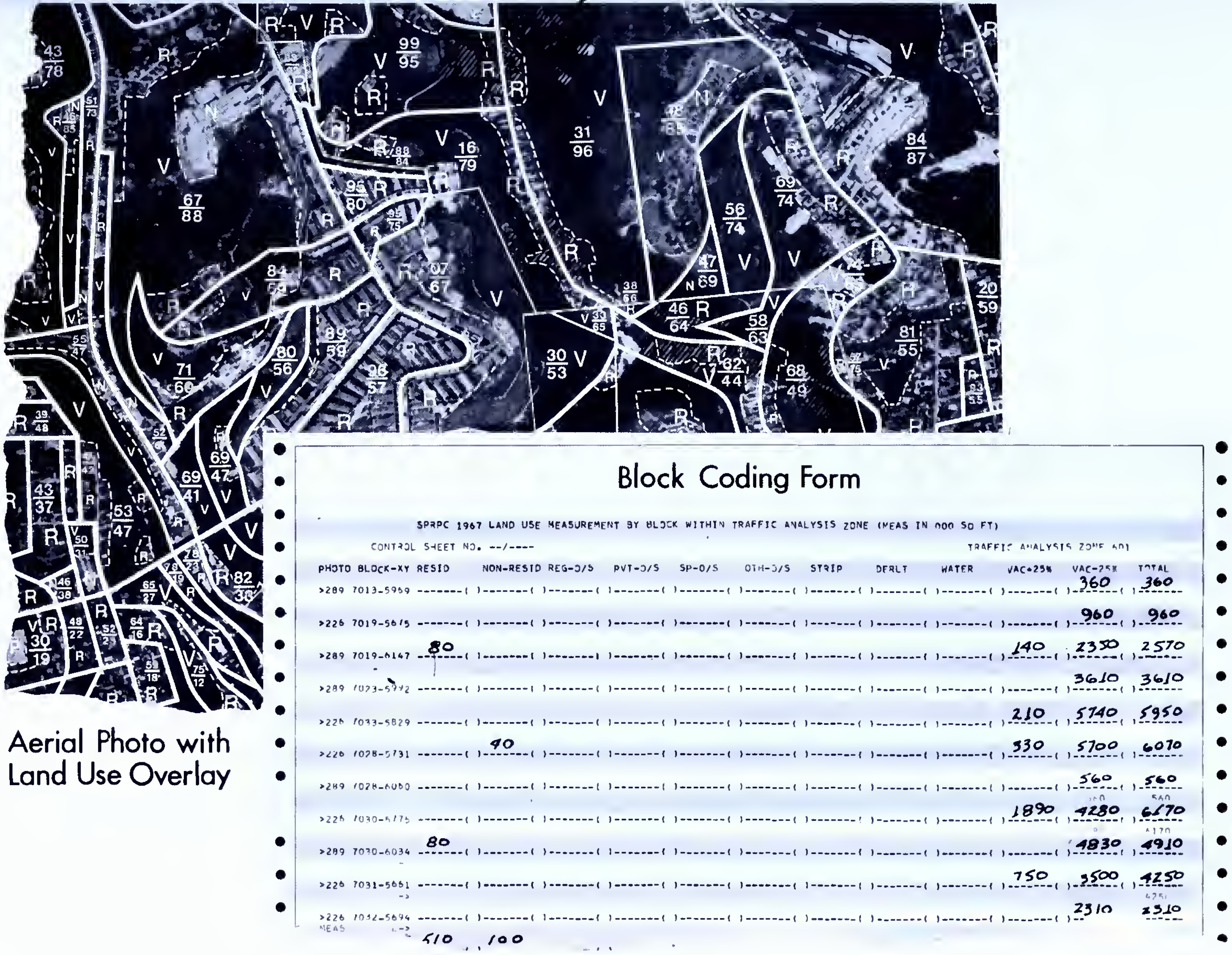
Wade G. Fox, Assistant Director for Data Services
Southwestern Pennsylvania Regional Planning Commission

In a review of existing development patterns in the Southwestern Pennsylvania Regional Planning Commission (SPRPC) six-county region (Allegheny, Armstrong, Beaver, Butler, Washington and Westmoreland) it is evident that the rugged terrain has played a vital part in the shaping of the development in the Pittsburg area. For this reason, during the development of the forecasting technique to be used by SPRPC, the slope of the land was identified as an essential component of the forecasting and analysis process. Since computer mathematical models, coupled with the more conventional planning techniques were to be employed in the planning process, it was a requirement that both a quantitative measure as well as graphical representation of the slope be obtained.

To obtain minimum quantitative measure, the amount of undeveloped land with slope exceeding 24 percent was identified and measured. However, for the graphical representation of slope, which was to be used for analysis purposes, it was determined necessary to identify all land by four major slope classifications. The compilation for this amount of detail for an area of 4,600 square miles was a substantial undertaking; therefore, as many shortcuts as possible were taken to hold down the cost and to expedite the program.

The first step in the process was to delineate, on prints of the terrain separation (brown) of the 7½ minute USGS quadrangles, the slope in four major categories (less than 9 percent, 9 to 16 percent, 17 to 24 percent, and 25 percent and over). This was a manual interpretation using templets to identify the various slope categories. The three steepest slope categories were color coded on the terrain prints. Next, a lined drawing of the slope categories was made on mylar in ink, and each of the three steepest slope categories identified by a different "Zip-a-Tone" pattern. This completed Phase 1, which resulted in a four-category slope map at the scale of 1" = 2000'. The slope overlays are used in conjunction with reproducible copies of the black and blue separations of the USGS quadrangles. This series of maps is used for detailed review purposes, however, for analysis on a regional basis this series of maps was considered too cumbersome because of size and bulk, therefore, it was necessary to reduce these to a more workable scale. This process will be explained later in the article.

To obtain the quantitative measurement of undeveloped land with slope in excess of 24 percent, a panograph was employed to transfer the steep slope areas onto land use overlays of aerial photographs. On these 1" = 500' and 1" = 880' scale overlays, various categories of developed land and water areas as well as "vacant" land had been delineated, using photo interpretation techniques. Using



Aerial Photo with Land Use Overlay

Block Coding Form

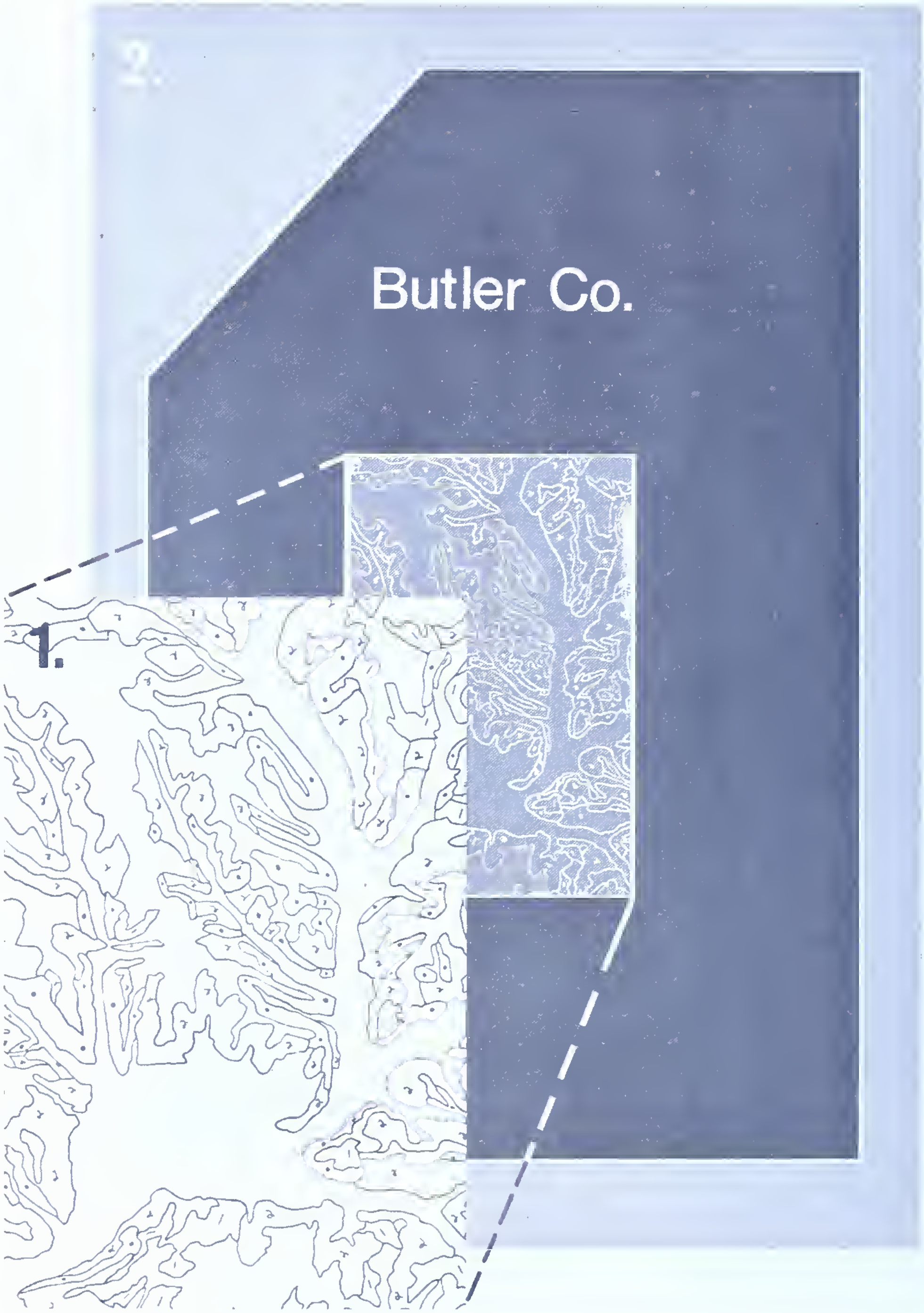
SPRPC 1967 LAND USE MEASUREMENT BY BLOCK WITHIN TRAFFIC ANALYSIS ZONE (MEAS IN 000 SQ FT)

CONTROL SHEET NO. --/----

TRAFFIC ANALYSIS ZONE 601

PHOTO BLOCK-XY	RESID	NON-RESID	REG-O/S	PVT-O/S	SP-O/S	OTH-O/S	STRIP	DERLT	WATER	VAC+25%	VAC-25%	TOTAL
>289 7013-5969											360	360
>226 7019-5675											960	960
>289 7019-6147	80									140	2350	2570
>289 7023-5992											3610	3610
>226 7033-5829										210	5740	5950
>226 7028-5731		40								330	5700	6070
>289 7028-6060											560	560
>226 7030-5775										1890	4280	6170
>289 7030-6034	80										4830	4910
>226 7031-5661										750	3500	4250
>226 7032-5694											2310	2310
MEAS	510	100										

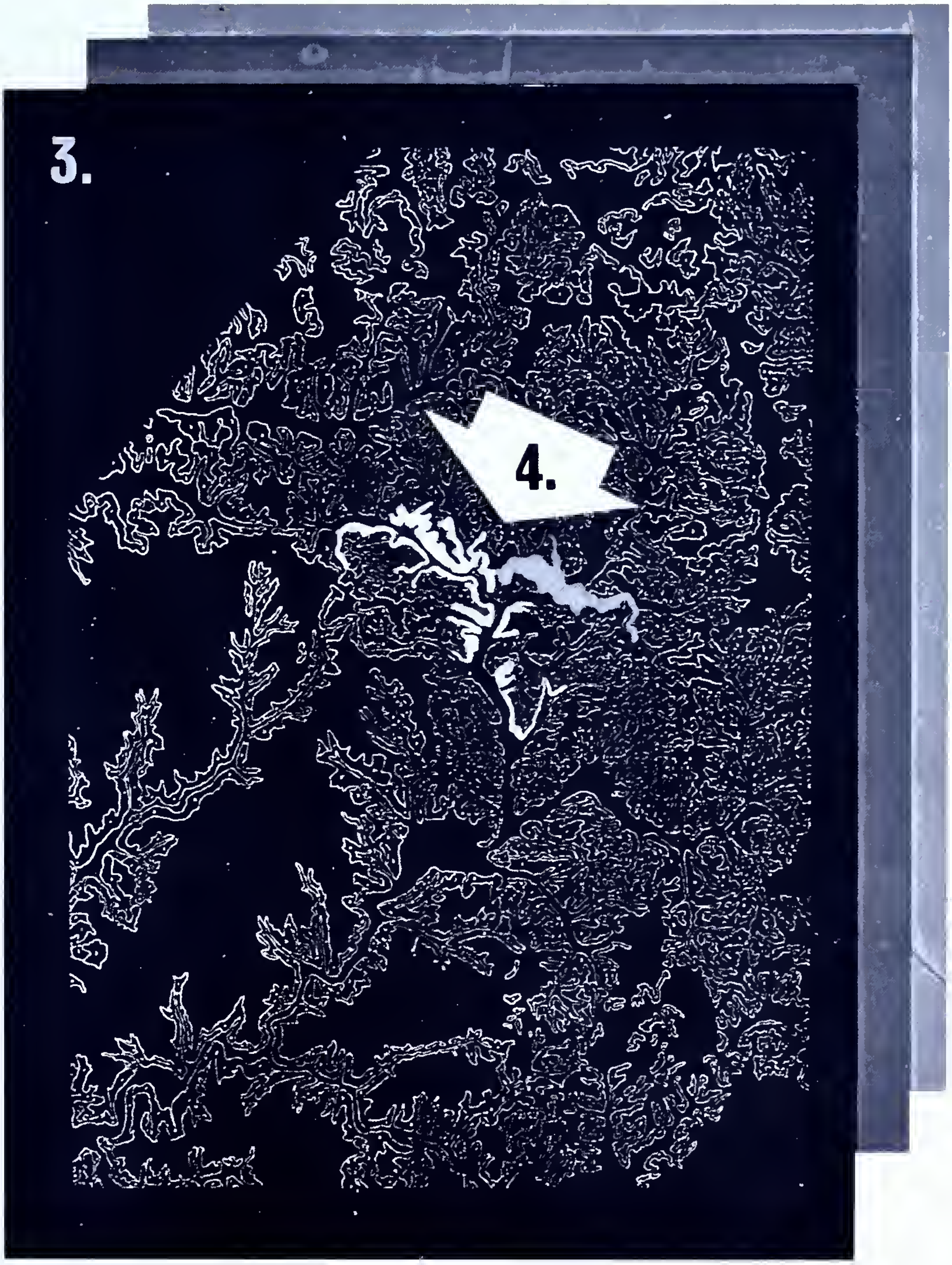
Figure 1: Example of Aerial Photograph with land use overlay and Block Coding Form.



1. Reduce 1"=2000' slope overlays to 1"=4000' negs.

2. Strip into county map composite.

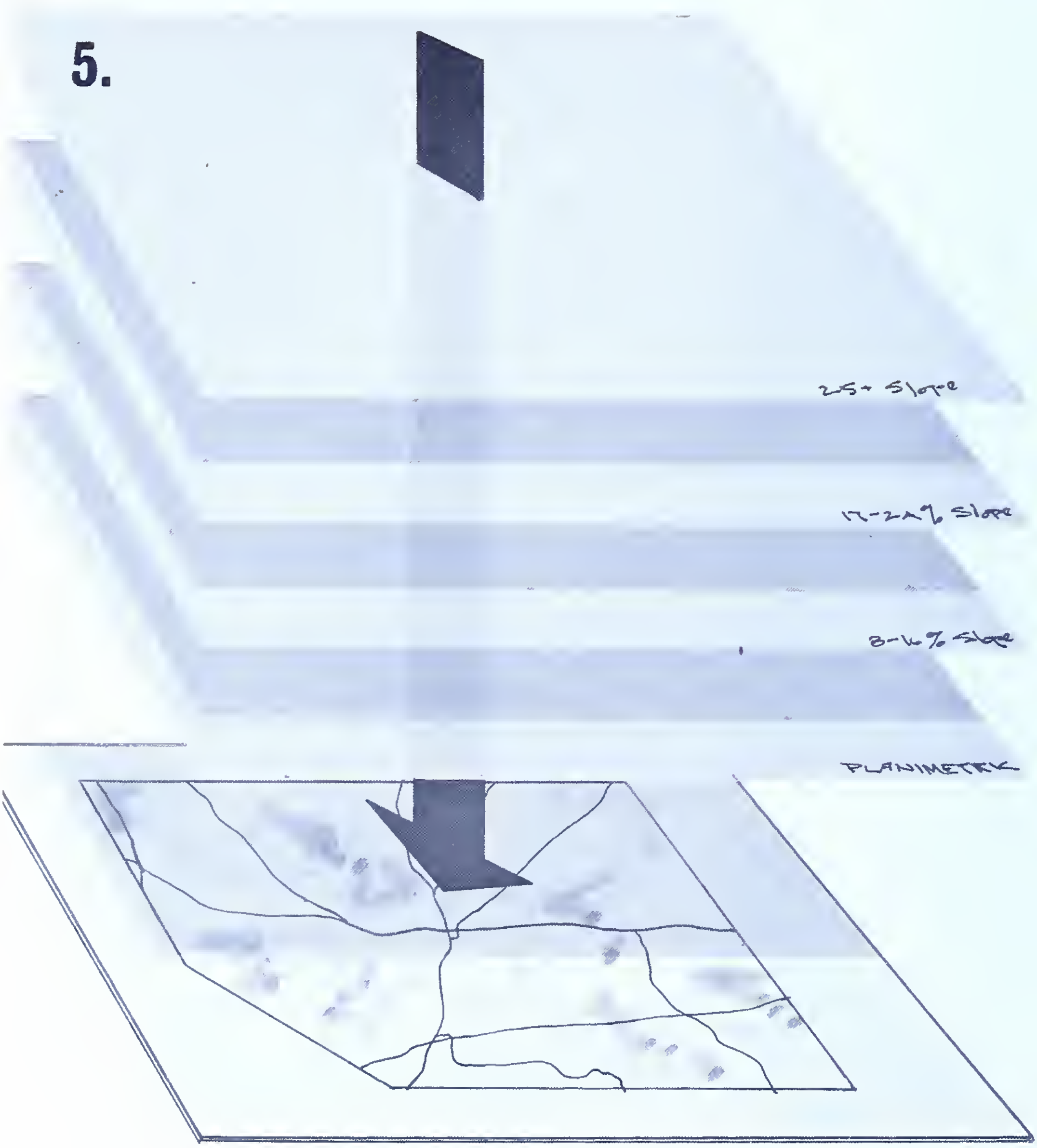
Figure 2a: Process followed to produce county slope maps.



3. Reproduce three Strip-Rite negatives.

4. Peel off each slope category.

Figure 2b: Process followed to produce county slope maps.



5. Reproduce composite base map of three slope categories and planimetric detail.

Figure 2c: Process followed to produce county slope maps.

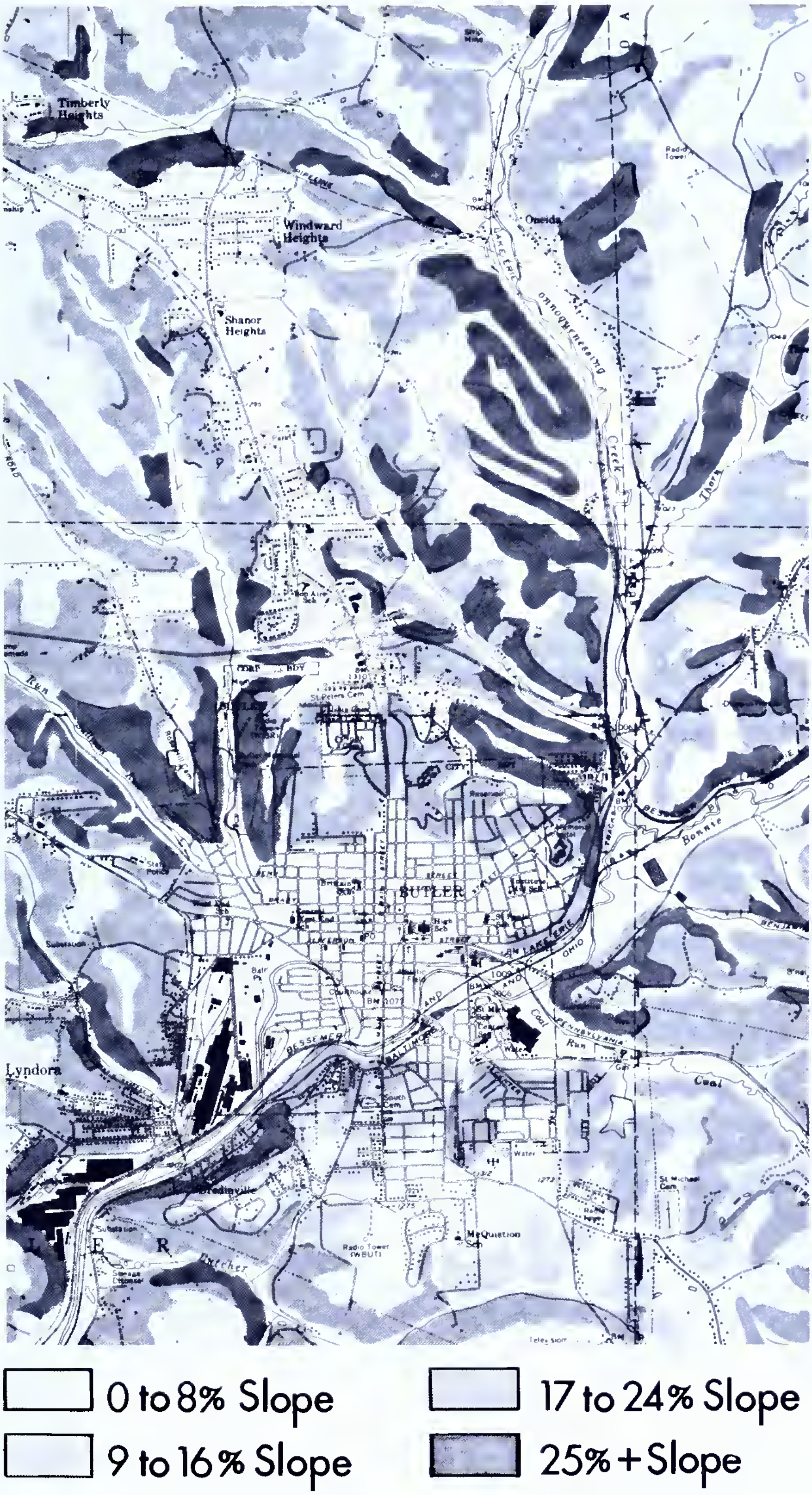


Figure 3: Example of completed section of county slope map.

the panograph to bridge the scale difference the "vacant" land areas were further defined into two categories—land with slope less than 25 percent, and land with slope 25 percent or greater. These two categories, for obvious reasons, were given the names "vacant usable land" and "vacant unusable land". Then, as part of the normal land use survey procedures, (see figure 1) the two "vacant" categories were measured along with the other land uses on a block basis (over 50,000 block were delineated in the SPRC region). This completed Phase 2 of the process where a quantitative measure of slope was available for computer processing.

As part of the SPRPC cooperative planning process, which involves various planning departments within the six-county region, it was determined essential that the four-category slope map be reproduced on a county-by-county basis to supplement the individual USGS quandrangle. The scale decided upon for the county composite slope map was 1" = 4000' which would conform to an existing series of data overlays that SPRPC had already developed at that scale.

Since the slope information had become an essential part of the planning process, it was considered necessary that it be combined with our county base maps of reduced USGS quadrangles at the 1" = 4000' scale. To achieve a composite of the USGS planimetric information together with the four slope categories on a single base map, it was necessary to use mechanical screens to depict the three steepest slope categories.

The following procedure was used to produce the slope map (see figure 2):

1. The slope overlays at 1" = 2000' scale were photographically reduced to 1" = 4000' scale.
2. The reduced negatives were "stripped" together for each county in the region (actually due to the size limitations, two counties were done in two-parts each).
3. From the county composite slope negative three "Strip-Rite" contact prints were reproduced—one for each of the three steepest slope categories. This photographic process etched the slope lines onto a red material that is adhered to a clear mylar base material.
4. Each slope category separation was then "peeled"—that is—the areas encompassed by the line for a particular percent of slope was cleared by peeling it off the mylar. The last manual operation was to opaque out all lines on each separation that belonged to the other slope categories. The results were three negative separations for each county, one depicting the slope category 9 to 16 percent, one for the 17 to 24 percent, and one for the 25 percent and over. Land area less than 8 percent of slope was left clear.
5. The final step was to reproduce the composite county map containing the three steepest slope categories and the planimetric detail. A mechanical screen was selected for each of the slope separations which would result in a light tint of gray for the more gradual slope, and a dark tint of gray for the steepest slope. Since the USGS planimetric detail was to be mose

prominent, no screen was used at all, and a black line effect was achieved. The composite map was created on a reproducible material so that diazo prints may be obtained.

An example of the resulting composite map is shown in figure 3. SPRPC staff has found this map to be very useful in its planning programs. Not only can future development forecasts be located more easily, but highway, as well as water and sewer planning on an areawide basis has been simplified.

Slope maps that are available at the SPRPC office include:

1. 1″ = 2000′ USGS 7½-minute quadrangles for those areas of the six-county region that had the quadrangles available as of 1966. The four slope categories are shown by patterns and may be reproduced with planimetric or contour USGS separations.
2. 1″ = 4000′ county maps showing all four categories of slope. For the counties of Allegheny, Armstrong, Beaver, Butler, Washington, and Westmoreland.
3. 1″ = 2 miles six-county region map showing areas with slope of 15 percent or more. Slope overlay may be printed with a variety of base maps at the 1″ = 2 miles scale.

TENTH ANNUAL CURRICULUM CONFERENCE

The Pennsylvania Department of Education for the tenth consecutive year is sponsoring a Curriculum Conference at Shippensburg State College, June 19-22, 1973. One of the sessions is called, "Man and the Environment – A New Approach to the Teaching of Geology", and will be of interest to earth and space science teachers. The workshop will stress the environmental aspects of geology which are most important in a secondary school level. Several speakers will present topics on engineering geology, ground-water, mineral resources, topography and their effects upon man. An environmental geology field trip is planned.

The conference begins with registration at 1 p.m., Tuesday, June 19th and closes after lunch, Friday, June 22nd. The overall cost including registration, meals and room is $35 if a room is shared and $45 for a single room. For commuters: the registration fee of $10 should be submitted with the pre-registration form. Meal tickets can be purchased at the conference registration desk.

Interested persons should contact *Mrs. Bertha P. Boyd, Conference Coordinator, Department of Education, Box 911, Harrisburg, Pennsylvania, 17126; Phone (717) 787-5218.*

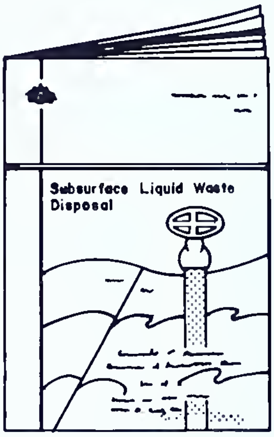
Registration for the conference closes June 1 or earlier if workshop quotas are filled.

SUBSURFACE LIQUID WASTE DISPOSAL -- A NEW PUBLICATION

With our population and industrial growth, the problems of environmentally acceptable waste disposal have become a serious concern. Of particular note are industrial liquid wastes which are difficult to store and treat at the surface. One solution considered is injection of these liquid wastes into deeply buried rocks. However, there is a mixed opinion with regard to their success and the possible environmental danger.

A new publication, "Subsurface Liquid Waste Disposal and Its Feasibility in Pennsylvania", has been released by the Bureau of Topographic and Geologic Survey. It provides a background for decisions that will be necessary on the part of industry, government, and the public in order to carry out a safe and sane liquid waste disposal program. Regulatory agencies must be able to answer with a high degree of certainty:

1. Where is the injected liquid going, both initially and as long as it is potentially hazardous?
2. What will the effects be, both direct and indirect, present and future, upon our environment?



Environmental Geology Report 3, "Subsurface Liquid Waste Disposal and Its Feasibility in Pennsylvania", is written by Dr. Neilson Rudd, an expert on fluid mechanics and the subsurface behavior of rocks. Continuing in the format of the "EG" series of reports, the author has used diagrams, sketches, and tables to illustrate a technical and complex subject. As an additional aid we have color-coded those headings, sentences, and paragraphs which provide the basic "thought" or "meat" of the page. Again, this report attempts to bridge the gap between fundamental geologic facts and the real-world, daily needs of an every changing society.

We continue to say that geology has an important input in improving and protecting the environment of Pennsylvania. It is for this reason that the Environmental Geology Series of publications are designed to present information that will assist in defining the most effective use and protection of our land and mineral resources.

Environmental Geology Report 3 may be obtained by writing to the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. The cost per copy is $2.00 plus 6% state sales tax for Pennsylvania residents.

LILLIAN HEEREN - THIRTY YEARS AS A DRAFTSMAN

Miss Lillian Heeren, Draftsman III for the Oil and Gas Division of the Bureau of Topographic and Geologic Survey completed 30 years of continuous service on March 14, 1973 as Head Draftsman for the Division. She was honored on her thirtieth anniversary with a luncheon given by her fellow workers and presented with a gold wristwatch.

Lillian had started at Carnegie Tech in the curriculum of Painting and Design. When the Second World War broke out she thought she would be of more use as a draftsman, therefore, she transferred to the University of Pittsburgh where she took up drafting. Dr. Daniel Bush, professor at the University and cooperating geologist with the Survey, needed a draftsman to finish Special Bulletin No. 1 entitled "Oil bearing sands in southwestern Pennsylvania" so he hired Lillian who completed her studies while working for the Survey.

In the early part of her career with the Survey she worked in field offices such as Pleasantville and Butler, as well as in her headquarter office in the Cathedral of Learning at the University of Pittsburgh where space was provided in the Geology Department. During her early years she spent most of her time on Survey projects that were given her by Dr. Richard E. Sherrill, head of the Geology Department at the University of Pittsburgh and Dr. Charles R. Fettke, head of the Geology Department of Carnegie Tech, both being cooperating geologists with the Survey.

During her Survey career she has completed hundreds of maps and figures for Survey publications authored by the Survey's geologists. In the early years the Oil and Gas Division rarely consisted of more than one geologist. Consequently, when the geologist would leave the employment of the Survey, Lillian would be the only one in the Division for months at a time until the vacancy was filled. During those periods, her work would be supervised by the State Geologist in Harrisburg. Lillian has served under all five State Geologists of the Fourth Pennsylvania Geological Survey; namely, Dr. George Ashley, Dr. Ralph Stone, Dr. Stanley Cathcart, Dr. Carlyle Gray, and the current State Geologist, Dr. Arthur A. Socolow.

Of the reports published by the Fourth Survey, Lillian has drafted the illustrations for 67 major reports, some of the maps taking months to draft for printing. Her illustrations have appeared in many other publications and technical articles. She has seen major changes in drafting techniques and has kept up with all of them. One of the major changes being the scribing method with the use of stick-up letters and symbols for map making instead of using ink drafting pens and freehand lettering. A story of Lillian and her picture was recently published in the Pittsburgh Press Sunday's issue in an article "Happiness is doing a man's job".

Lillian has always loved to travel. She has taken many trips with her friends from the University of Pittsburgh and Carnegie Museum. One of her most pleasurable excursions was a trip around the world by boat.

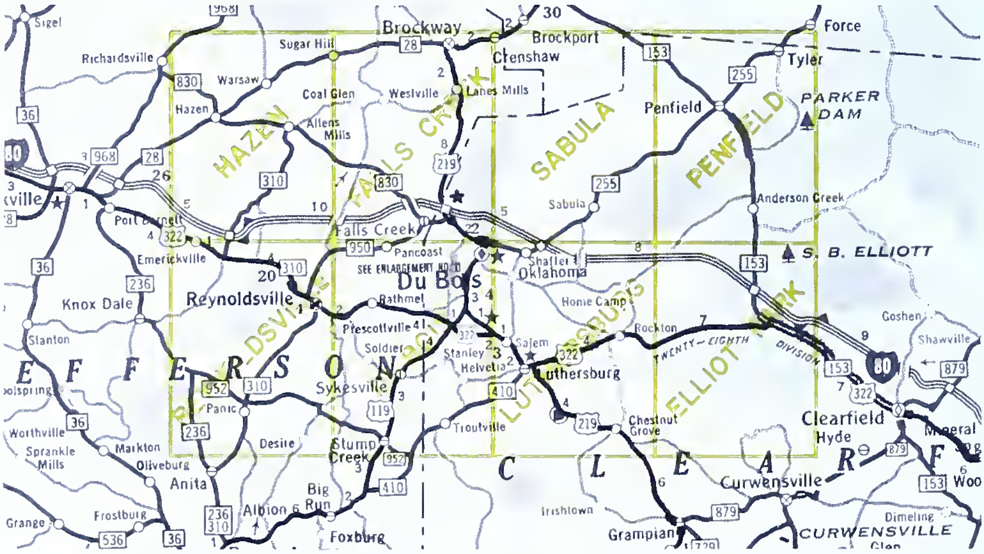
She plans to continue with her Survey drafting duties, and we feel it is most fortunate to have a draftsman of Lillian's caliber whose ability can easily be seen in the Survey's published reports.

GROUND WATER PROJECT AROUND DUBOIS AREA TO BEGIN

Summer 1973 will mark the beginning of a ground water project in the DuBois area which will include parts of Clearfield and Jefferson Counties. The project is to cover eight 7½-minute quadrangles. Geologic mapping of these quadrangles has recently been completed, but not yet published by our Field Geology Division. These are the Hazen, Reynoldsville, Falls Creek, DuBois, Sabula, Luthersburg, Penfield, and Elliot Park quadrangles.

The project will be undertaken by Evan T. Shuster in the Environmental Geology Division. The main objectives of the study will be to determine the quantitative and qualitative aquifer characteristics of the near-surface geologic units. Because the area is expected to undergo significant growth in the near future, Evan will examine the relative potential of these units as sources of potable ground water and the ability of this and geologically similar areas to sustain ground water development.

Field work for this project is expected to require two seasons and the study should be ready for publication by mid-1975.



THE OLD WOODBURY ZINC-LEAD OCCURRENCE, BEDFORD COUNTY COMES TO LIGHT

As part of a research study of all known Zn-Pb occurrences in Pennsylvania, the Woodbury Pb-Zn occurrence in northern Bedford County was relocated by Survey staff geologists John H. Way, Jr. and Bob C. Smith, II. The only known reference to this occurrence is McCreath (1879, p. 280) who stated only the following: "S. Snyder's farm, three miles west from Woodberry, Bedford County. Surface ore: Metallic lead 25.80 and Metallic zinc 32.97%."

To date, the mineralization that was observed occurs as a 25 x 60 foot gossan scar in a field on the private farm of Jacob J. Snyder, whose home is located 3.8 miles west of the present town of Woodbury and 1.5 miles NE of Lafayetteville along Pennsylvania Route 867. Within this scar, crops are severely stunted and there is abundant limonite float in the fields. Some of the limonite contains appreciable smithsonite, galena, anglesite, and cerussite. Fresh pieces of dolomite breccia contain thin veinlets of calcite and sphalerite. To the best of the owner's knowledge, neither geochemical nor geophysical studies have been conducted at this occurrence.

The geology of the area is poorly known, although Survey work is now in progress. The state geological map (Gray and Shepps, 1960) shows the host rock to be Cambrian Warrior dolomite. However, no fault is shown which could have produced the observed tectonic breccia. The trace of another fault ¾ mile to the NW is shown on the state map. It probably is a southeast dipping thrust fault that developed on Ordovician Reedsville shale. Conceivably it could pass beneath the gossan scar at a depth of 2000 to 4000 feet. This thrust contains Beekmantown Group sediments, some of which are known to contain oregrade zinc elsewhere in the Appalachians. Other thrust faults are known to be favorable hosts for ore deposits.

Platt (1881) on p. 53 of his report on Blair County states "In a quarry one mile north of Lafayetteville, the limestone is massive, dark colored, much specked with quartz and calcite, and with some very small spurs of zinc ore." This occurrence would be approximately ¾ mile southwest of the J. J. Snyder farm.

Stevenson (1882) on p. 328 of his report on "iron interests" in Bedford County states "The most marked line of ore-bearing sands is in South Woodbury and Bloomfield townships. . . . not following the strike of the rocks but bearing almost north and south. . . . The existence of limonite ore along this ridge has been fully proved by prospecting pits . . . at comparatively short intervals."

Further field work, and possibly some reconnaissance geochemical prospecting, is planned by the Survey. This will be described in a future issue of *Pennsylvania Geology*.

Because this area is private, permission to enter the property is required by the Snyders.

Bob C. Smith, II

REFERENCES:

Gray, C. and V. C. Shepps (1960) Geologic Map of Pennsylvania, Pa. Geol. Survey, 4th ser., 1:250,000.

McCreath, A. S. (1879) Second Report of Progress in the Laboratory of the Survey, Chapter 5, Pa. Second Geol. Survey, MM, 438 pp, 1 pl.

Platt, F. (1881) The Geology of Blair Couty, Pa. Second Geol. Survey, T, 311 pp.

Stevenson, J. J. (1882) The Geology of Bedford and Fulton Counties, Pa. Second Geol. Survey, TT, 382 pp, 2 mps.

PENNSYLVANIA SURVEY LIBRARY NEEDS

Scores of individuals and institutions have generously responded to our earlier appeal for replacements for our flood-ravaged library. We have received contributions of many important out-of-print volumes and long runs of professional journals.

Now that we have been able to take stock of what we received, we have also been able to focus on those items which are still missing and would like to replace.

Listed below are the journals and the particular volumes for which we are issuing an appeal. We would welcome any portions of these missing series. We are prepared to handle shipping costs (preferably Express Collect) and, where desired for financial records, will furnish a written acknowledgement and estimated value of any items donated. Please direct shipments to Arthur Socolow, State Geologist, Pennsylvania Geological Survey, Towne House, Harrisburg, Pennsylvania 17102.

AAPG Bulletin	vol. 1 - 9,12	1916 - 1925, 1928
American Journal of Science	vol. 260 - 272	1960 - 1972
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	vol. 68 - 81	1959 - 1971
Journal of Paleontology	vol. 1 - 14	1926 - 1940
Journal of Petrology	vol. 1 - 12	1959 - 1971
Journal of Sedimentary Geology	vol. 1 - 25	1930 - 1955
Micropaleontology	vol. 1 - 17	1954 - 1971
Mineralogical Magazine	vol. 1 - 37	1934 - 1971
Sedimentary Geology	vol. 1 - 7	1964 - 1971
Sedimentology	vol. 1 - 17	1954 - 1971
Tectonophysics	vol. 1 - 12	1959 - 1971
Water Resources Research	vol. 1 - 7	1964 - 1971

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In Cooperation with The U.S. Geological Survey

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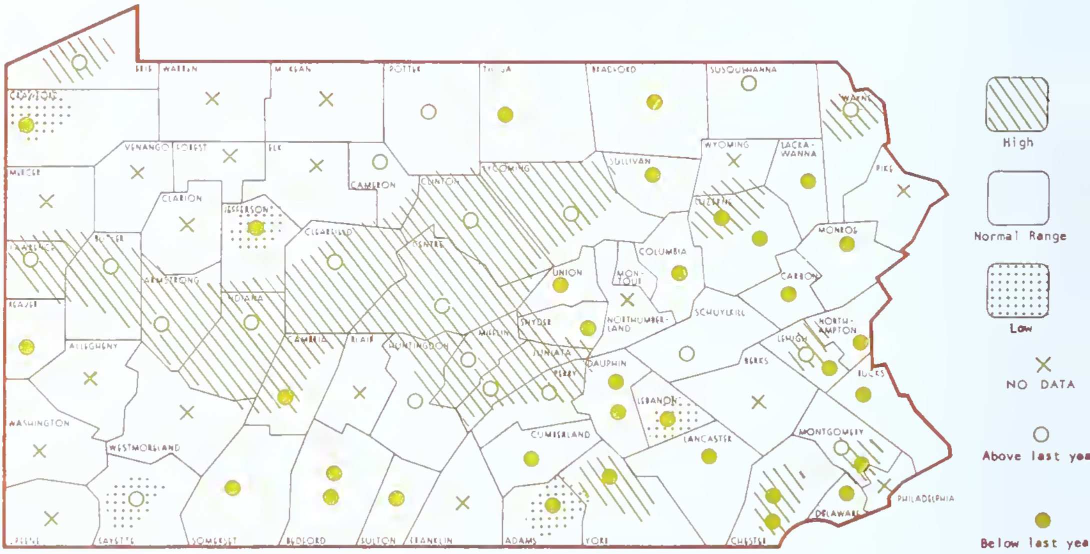
In Cooperation with The U.S. Geological Survey

MARCH 1973

GROUND-WATER LEVELS



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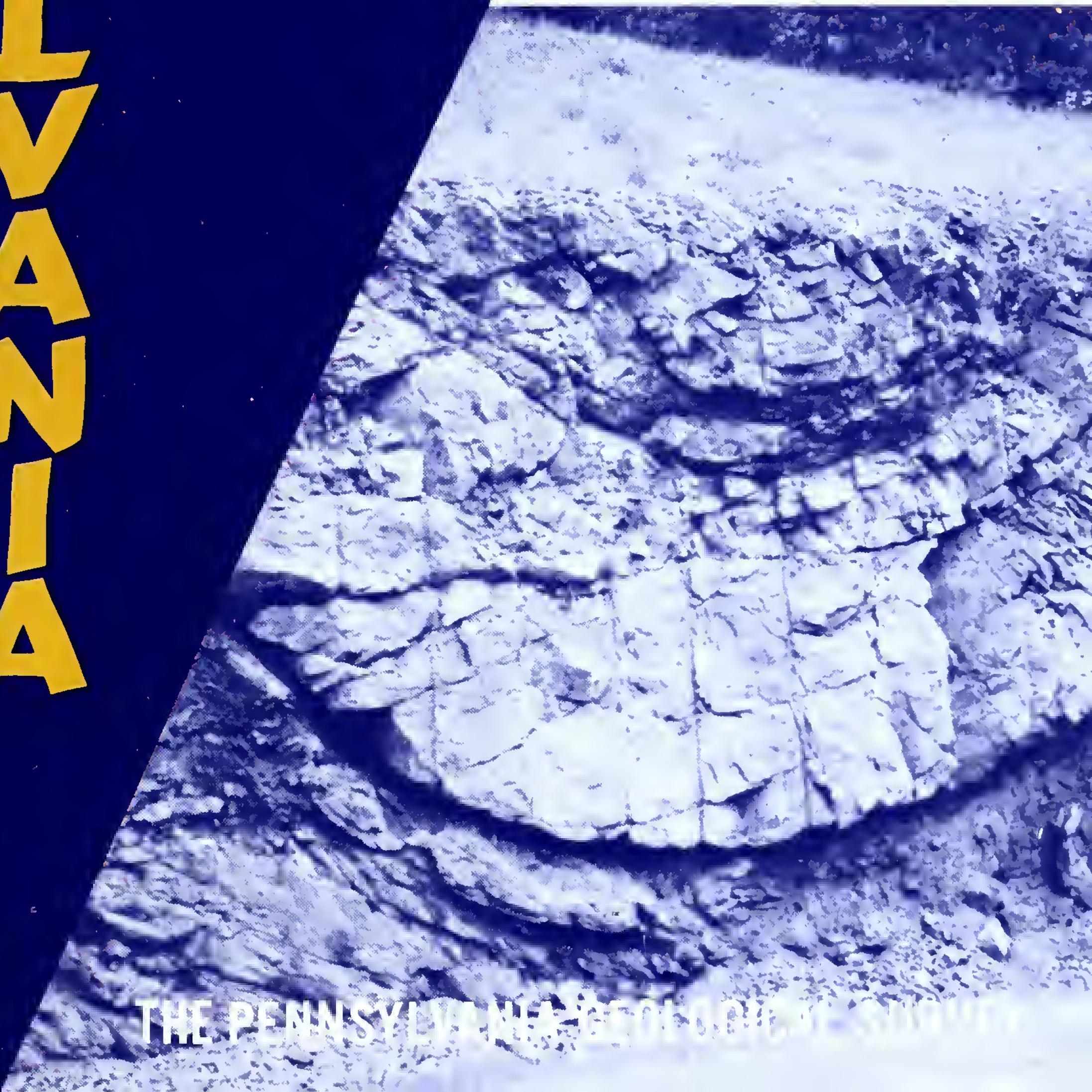

THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: A striking syncline in the Pottsville Formation along Route 81 near Ravine. Photo courtesy of William Bolles, Pennsylvania Department of Education.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

JUNE 1973

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

OUR OTHER MINERAL RESOURCES ARE ALSO SCARCE

For many months we have been hearing reports on an energy crisis – and there really is one, as the demand for energy of all sources continues to grow faster than the supply of energy from all sources. Now, a new threat to the strength of our economic society has been highlighted as the U. S. Geological Survey has released a comprehensive report showing that for most of our mineral needs, the United States already is a major importer and faces further critical shortages in the next twenty years.

U. S. Geological Survey Professional Paper 820, "United States Mineral Resources" reviews more than 60 mineral commodities which are essential resources in our industrial society and finds that we possess less than half a dozen commercial minerals in major quantities. For the rest, we face fast increasing shortages which will call for (1) even more imports than we have now, (2) revised industrial technology, (3) developing substitutes, (4) increased recycling, (5) intense new exploration, and (6) improved mining and mining technology.

As one looks ahead in the energy "crisis", solutions appear on the horizon in various forms, such as; new oil discoveries, coal liquifaction and gasification, oil shale development, tar sands development, acceptable nuclear energy, geothermal energy, etc.

Ironically, with much less fanfare and ballyhoo about our other minerals shortages, they may actually be much more serious to our society, inasmuch as realistic solutions to their shortages are not on the horizon. Among our existing critical shortages are ores of aluminum, chromium, manganese, mercury, silver, tungsten, asbestos, and nickel. But joining the critical list soon will be lead, zinc, titanium, uranium, barite, high-quality clays, and many others.

While most people can translate energy shortages into personal impacts such as lack of heat or transportation fuel, most persons don't relate to a widespread industrial minerals shortage. Yet the impact of such shortages will be tremendous, ranging from high-priced imports which will seriously affect our balance of payments, to a need to alter and even curtail our voracious, mineral consuming technology as we find ourselves running short of one item after another.

While geologists have been aware of the projected mineral shortages, the U. S. Geological Survey has done a real service in highlighting the problem in Professional Paper 820, "United States Mineral Resources." This 722-page report is available from the U. S. Government Printing Office, Washington, D. C. 20402 for $9.15. A 19-page summary of the big report is available free from the U. S. Geological Survey, Washington, D. C. 20244; it is listed as Geological Survey Circular 682, "Summary of the U. S. Mineral Resources".

Arthur A. Socolow

LAKE ERIE
REACHES RECORD HIGH LEVEL

High water has been a recurring source of problems for Pennsylvanians throughout the history of the Commonwealth, but perhaps never more so than in recent times. Certainly the Great Flood of '72 will go down in history as one of the worst catastrophes ever to strike the Keystone State. This year (1973), attention is focused on the northwestern corner of the state where less destructive, but similarly unequaled high water is taking place along the approximately 45 miles of Lake Erie shoreline in Erie County.

Record high water levels are being recorded on Lake Erie this year. Changes in the lake level are a common event. The level of Lake Erie will normally vary by about one foot in an average year, with the highest water peak in June and the lowest level in February (Fig. 1). In addition to the annual cycle, long term variations can take place (Fig. 2). These do not follow any regular cycle, and reflect long term variations in the amount of precipitation and evaporation in the Great Lakes Region. Since the mid 1960's, when Lake Erie was below normal level, the lake level has been gradually on the rise until, in the first half of 1972, the level was approximately one foot above normal. This situation continued until June, when Tropical Storm Agnes arrived, dumping from 4 to 6 inches of rain along the south shore of the lake. The lake responded to this added runoff by reaching its peak in July, rather than June. Above-normal precipitation continued for the remainder of 1972, bringing about a continued increase in the already above-average lake level. The lowest water for the past fall-winter season came in October, 4 months earlier than usual. Since that time, the lake level has been on an almost continuous rise. A new record has been set for every month since September 1972, and a new all time record high level was set in March of this year, with the lake almost 4.3 feet above the low water datum. The rise is expected to continue until May, when, as of this writing, a level of 4.75 feet above low water datum may be reached. After May, according to the prediction of the Lake Survey Center of the National Oceanic and Atmospheric Administration, a gradual decline should begin until by October it returns to below-record levels.

The rise of the water level by itself does not pose many serious problems. However, when coupled with strong winds, the high levels can be the cause of significant flooding and erosion. The accelerated erosion results from higher than normal waves which are capable to attacking shoreline features with unusual force. These waves are also capable of reaching farther inland than normal, causing damage in areas usually considered to be "safe" from wave attack. Owners of lakefront property are frequently finding their property disappearing before their eyes with each new storm. It is fortunate that most of the Pennsylvania shoreline is protected by bedrock cliffs which range from 50 to 100 feet above the lake level, and which are somewhat resistant to rapid erosion. However, one major feature in Pennsylvania which is in danger due to increased erosion, is Presque Isle, a 6 mile long sand spit which encloses Erie Harbor, and which houses the Pennsylvania State Park at Erie, an important recreational resource in northwestern Pennsylvania. This spit consists of only unconsolidated sand, and is very easily eroded. In addition, much of it is less than 10 feet above the lake level, allowing waves to wash inland a considerable distance, damaging roads and other installations. A storm last January resulted in an estimated $260,000 in damage at the state park. Work was quickly begun to repair the damage and $25,000 to $30,000 had been spent when another storm struck on St. Patrick's Day, proving the repair efforts to have been in vain. Perhaps the greatest danger is that Presque Isle could be severed from the mainland. The French term for peninsula, *"presqu'île"* ("almost [an] island") is especially appropriate for this spit since the outer portion of it is over one mile in width while the near-shore end is only about one-tenth of a mile wide. Erosion along the narrow section has long been a problem, and with this year's record lake level, it is of particular concern to residents of the Erie area.

The problem of flooding occurs as a result of a tilting of the lake level caused by strong, sustained winds. This effect is most noticeable at the eastern and western ends of the lake. A simultaneous difference in lake level of as much as eight feet has been recorded during a strong, sustained northeast wind between Buffalo, New York, and Toledo, Ohio, as a result of this effect. Such a situation can result in severe flooding in low-lying coastal areas in Ohio. Differences in level between the north and south shores, which might effect Pennsylvania, can occur with a strong northwest wind but are generally not nearly as great due to the relatively short fetch of the wind in that direction. With the exception of Presque Isle and several localities near the mouths of creeks, most of the Pennsylvania shoreline is protected from flooding by the 50-100 foot bluffs which line the shore.

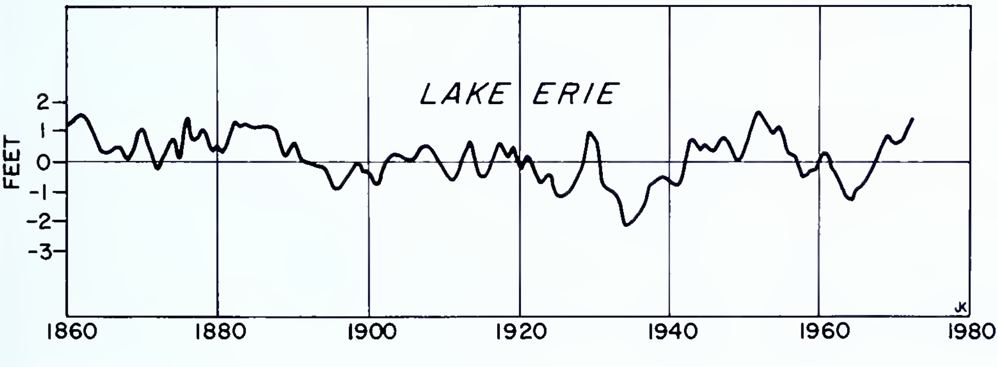


Figure 1. Elevation in feet, referred to LOW WATER DATUM of Lake Erie (period of record 1860-1972) (Courtesy NOAA Lake Survey Center).

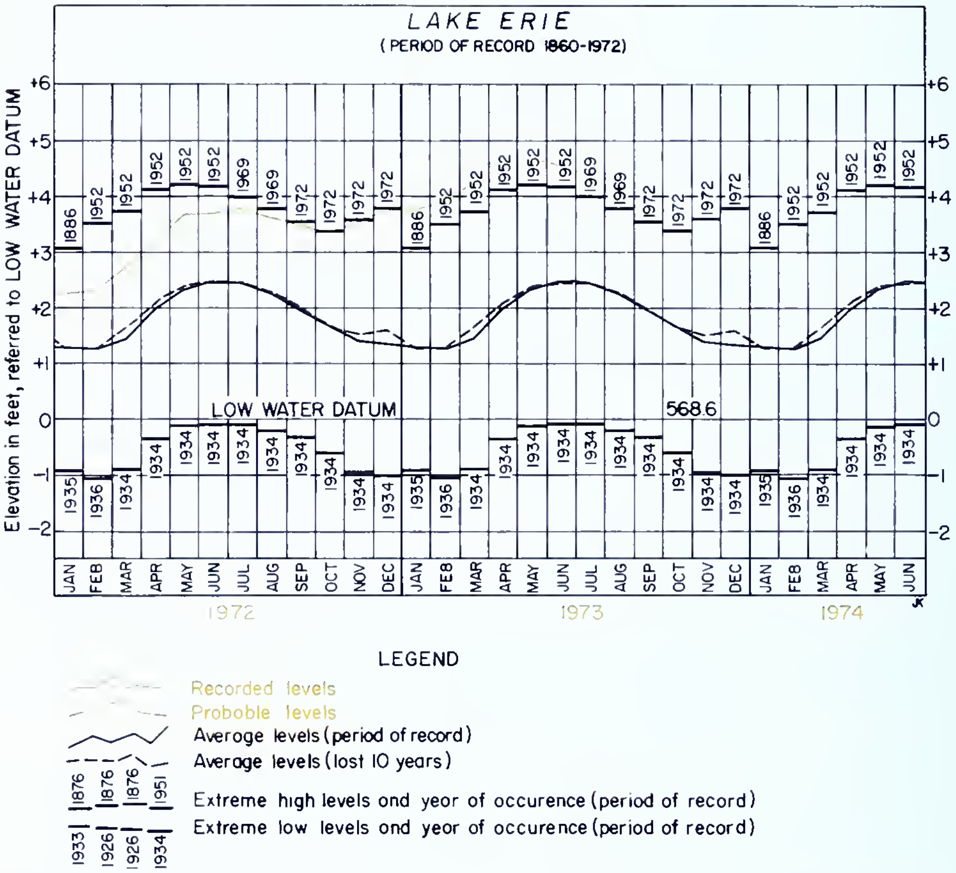


Figure 2. Long term variations in level of Lake Erie since collection of data was begun in 1860. (Courtesy NOAA Lake Survey Center.)

ACKNOWLEDGEMENT: We gratefully acknowledge the help of Mr. John Hanna, NOAA, Lake Survey Center, Detroit, Michigan, for supplying data on the lake levels.

John Barnes

[1] Erie Times, Erie, Pennsylvania, March 19, 1973.

BARITE-LIMONITE FROM THE ALTOONA-HOLLIDAYSBURG AREA

During the course of recent mapping in the Altoona region, Blair County, a previously unreported occurrence of barite in limonite has been found. The mineralization occurs approximately one mile north of the Hollidaysburg State Hospital (Fig. 1) in the Tonoloway Formation of Late Silurian age. The occurrence is most easily reached by driving east, southeast, from Route 764 past the sewage disposal plant and parking on the landfill site adjacent to a small quarry. A dirt road, just before the quarry, winds to the northeast behind the quarry and passes near two larger quarries off to the right. The barite-limonite locality is about 50 yards east of the road, north of the second large quarry (see inset on Fig. 1).

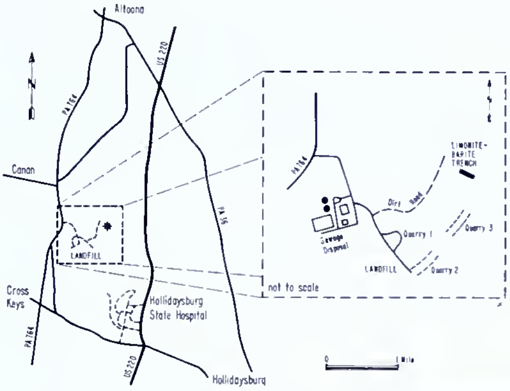


Figure 1. Location of Limonite-Barite.

The barite is white to gray in color, often forming intergrown crystalline masses. Most commonly it is intimately associated with limonite and mammilary goethite. Pure barite is uncommon, but small pieces can be found with crystals 3-5 mm long, 1 mm wide, extending upward from a crystalline base. Crystal growth zoning can be seen in some cleavage faces (Fig. 2). Individual crystals are less common than are masses of crystalline barite in the limonite. Limonite also occurs here without barite. No secondary minerals of lead, zinc, or copper have been observed; chemical analyses show: 170 ppm Zn; 50 ppm As; 20 ppm Pb and less than .1 ppm Ag.

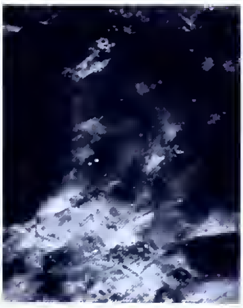


Figure 2. Growth zoning in barite crystals (photos by Les Chubb).

The mineralization is restricted to a relatively narrow, artificial trench in the hillside, approximately 10 feet wide, 30 feet long and 4 feet deep. The elongate shape of the cut suggests that the mineralization occurred along a joint or fault cross-cutting bedding, and the cut probably was made many years ago in search of limonite iron ore.

Several hundred yards south of this cut, the Tonoloway and Keyser limestones are exposed in two rather spectacular, elongate quarries. Stone removal was apparently concentrated along the contact of these two formations, probably in the lower portion of the Keyser Formation.

The Keyser in this area can be recognized by an abundance of fossils: corals, crinoids, brachiopods, algal stromatolites, and ostrocodes. The character of these limestone beds is quite variable and includes argillaceous nodular zones, thin- to thick-bedded fossiliferous and non-fossiliferous units, and even some pure dolomite beds. The lower portion of the Keyser consists of massively crystalline limestone with white and pink calcite veins and "eyes" and is referred to as "calico rock". Solution channels, flowstone and caves are common in the Keyser limestone.

The Tonoloway Formation, typically a thin-bedded to laminated, fine-grained limestone, is much more uniform in character than the Keyser. Thin layers of chert may occur near the top of this unit and fossils are rare. Secondary calcite crystals are abundant, filling vugs and cracks in many of the limestone layers. The type locality of celestite at Bellwood, north of Altoona, occurs in the Tonoloway and casts of salt crystals are plentiful along some bedding planes both at Bellwood and numerous other Tonoloway exposures. Collectors should also be aware of the possibility of finding galena and sphalerite as these minerals have been reported from the Tonoloway Formation north of McConnelstown in Huntington County (Platt, 1881), and from other localities in Pennsylvania (Rose, 1970).

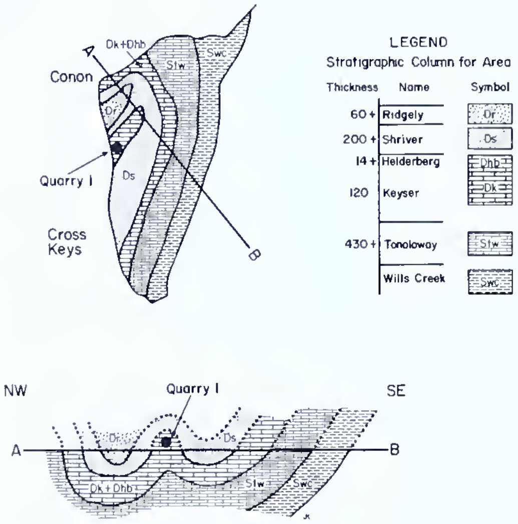


Figure 3. Geology and structure from Butts (1945).

According to Butts (1945) the geology of this area involves simple anticlinal-synclinal fold geometry of Upper Silurian and Lower Devonian formations (Fig. 3). However, recent work suggests that this geometry is complicated by faulting. The limestones in both quarries (#2 & #3) (Fig. 1, in set) dip southeastward and form the west limb of a syncline. In the small quarry (#1) adjacent to the landfill, an anticline is exposed which involves the Keyser and overlying Helderberg Formations, both slightly younger than the underlying Tonoloway Formation. Between this quarry (#1) and the two larger quarries (#2 & #3), a fault has thrust the west limb of the syncline up and over the anticline. This can be seen in Figure 4, a photograph of the small quarry (#1) looking to the north, and in Figure 5 the structural cross-section.

The limonite-barite mineralization, therefore, may be directly associated with this faulting, occurring either in a cross-fault related to this thrust, or a fracture or joint as a direct result of the faulting.

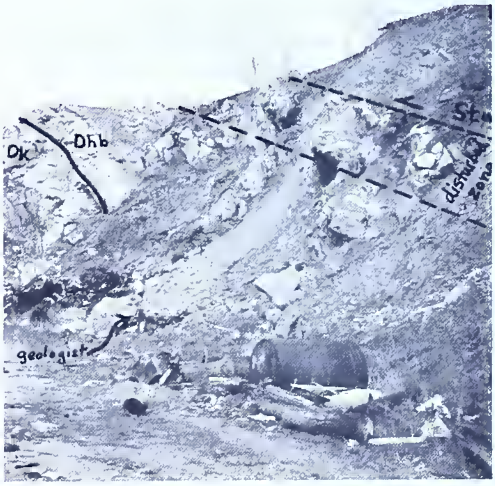


Figure 4. Quarry #1 looking north.

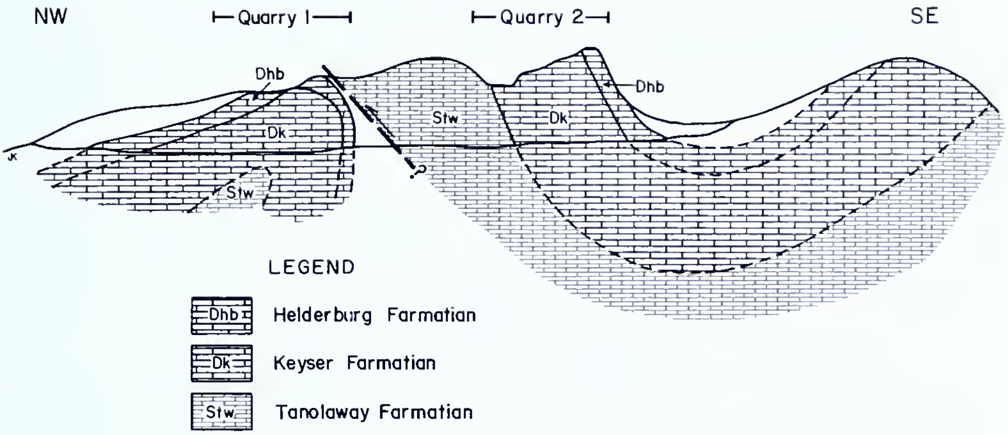


Figure 5. Cross section of quarry #1 and #2.

Butts, Charles, 1945, Description of the Hollidaysburg and Huntington Quadrangles: U. S. Geol. Survey, Folio 227, 20 p.

Platt, Franklin, 1881, The Geology of Blair County: Pa. 2nd. Geol. Survey, Rept. T, 311 p.

Rose, A. W., 1970, Metal mines and occurrences in Pennsylvania, Part 3-Atlas of Pennsylvania's Mineral Resources: Pa. 4th. Geol. Survey, M50, 14 p.

John H. Way, Jr.

GROUND-WATER AND GEOLOGIC STUDIES IN THE WILLIAMSPORT AREA

The Water Resources Division of the U. S. Geological Survey in cooperation with the Pennsylvania Geological Survey is mapping the geology of the unconsolidated deposits and evaluating the ground-water resources of a 450 square mile area that centers around Williamsport, Pennsylvania. The Pennsylvania Geological Survey is mapping the bedrock geology in support of this investigation.

The rapid growth of industry and population in and around Williamsport demands accurate and up-to-date hydrologic and geologic information for the most efficient and economical development of the area's ground-water resources.

The investigation was begun in 1971 and should be completed by 1975. The bedrock geology of the area is being mapped by Roger Faill and Richard Wells of the Pennsylvania Geologic Survey. The ground-water resources are being studied by Orville Bruce Lloyd, Jr. and John Stephenson of the U. S. Geological Survey.

Some expected products of the investigation are listed below:

(1) Maps showing the areal extent, thickness, water-bearing and water-quality characteristics of the bedrock formations and the unconsolidated alluvial deposits in the stream valleys.

(2) Maps showing the general distribution and orientation of fracture traces in the area and discussion of how they relate to the yield of wells.

(3) Maps showing the general distribution of precipitation, evapotranspiration and runoff and discussion of how their relation to one another varies with season and how these variations relate to the amount and kind of ground water available to wells.

(4) Evaluation of the role of induced infiltration from the West Branch of the Susquehanna and its tributaries as a source of water for wells constructed in the alluvial deposits.

The results of the investigation will be published as an interpretative report by the Pennsylvania Geological Survey in their Water Resources Report Series. The report will provide the information needed for the wise development of the area's ground-water resources.

STUDY BASEMENT FLOODING IN KINGSTON AREA

A study is in progress to evaluate the causes and alternative methods of controlling basement flooding in the Kingston-Luzerne area (Luzerne Co.) Penna. The study is being conducted as a cooperative project between the office of Engineering and Construction of the Dept. of Environmental Resources, the U. S. Geological Survey, and the Susquehanna River Basin Commission. Water Resources Report #28, Hydrology of the Pleistocene Sediments in the Wyoming Valley, written by Jerrald R. Hollowell, and published by the Pennsylvania Geological Survey, has provided most of background geologic and hydrologic information for this study.

Rainfall, ground-water levels from 38 observation wells, water levels in selected basements, and stream levels will be monitored for 18 months; and the distribution, composition and hydrologic properties of shallow subsurface sediments (0-30 ft.) will be determined. The record of water level rise and fall in basements will be correlated with rainfall, ground-water and surface-water levels in order to determine the effect of each on basement flooding. Lithofacies maps showing the thickness and distribution of sediments with similar hydrologic properties will be constructed to determine the routing of water from land surface to the water-table, and after it has reached the water-table, to points of discharge. This information will be used to determine the degree of susceptibility of any one area to basement flooding. Seasonal water-table contour maps, as well as water quality data, will be compiled to assist decisions by local authorities concerning future land-use and development.

Several working hypotheses are being tested that might explain basement flooding.

(1) Runoff, after heavy rainfall, percolates into basements on its way to the water table.

(2) Recharge from storm runoff in streams (such as Toby Creek) may raise the water table to elevations above the bottom of basements in the vicinity of the streams.

(3) Ground water may flow through relatively permeable abandoned stream channel deposits and, during times of high water, flood basements which have been excavated on or near these deposits.

(4) Water in abandoned coal mines may flow upward to the shallow water table and, thus, to basements through fractures, adits and boreholes, when the pressure is increased by large amounts of recharge on the hillside adjacent to the valley.

After the cause or causes of basement flooding have been established, measures that might alleviate the problem will be suggested.

CURRENT STATUS OF PENNSYLVANIA'S WATER WELL INVENTORY

Incorporation of the water well data into the computerized data retrieval system has the records of wells drilled in 46 counties on computer printout. This involves almost 1600 pages of printout and 12,500 wells. Information is also available on the remaining counties in the form of drillers' well completion reports which are on file at the Survey's Harrisburg Office. Well records for Adams County, however, were lost in the flood. When new records for this county become available they will be added to the program. The index map in Table I indicates those counties completed to date and the number of wells listed on the printouts for that county.

Assimilation of raw data into the data retrieval system is currently being done on a county basis so that the Geological Survey will at least have some coverage on all counties in the state. When this phase is completed, all counties will be updated and information incorporated into the system as it is received from the driller.

Data Form and Availability

The water well data goes through four steps. Each well is located as accurately as possible on 7½-minute topographic maps. All information is coded onto data sheets which are sent to the key-punch operator. Information for each well requires four key-punch cards. The computer program then produces four series of printout sheets which correspond to the four cards. These are:

1. The *master card* which shows the township, owner, location and well use;
2. The *well description card* which lists the total depth, casing length, screening, drilling method, water level and well yield;
3. the *hydrogeologic card* which identifies the topographic setting, the major and minor aquifers, depth to bedrock, type of bedrock, and the type of surficial material;

4. The *Pennsylvania supplement card* which adds the depths and yields of the water-bearing zones and lists any general chemical analyses.

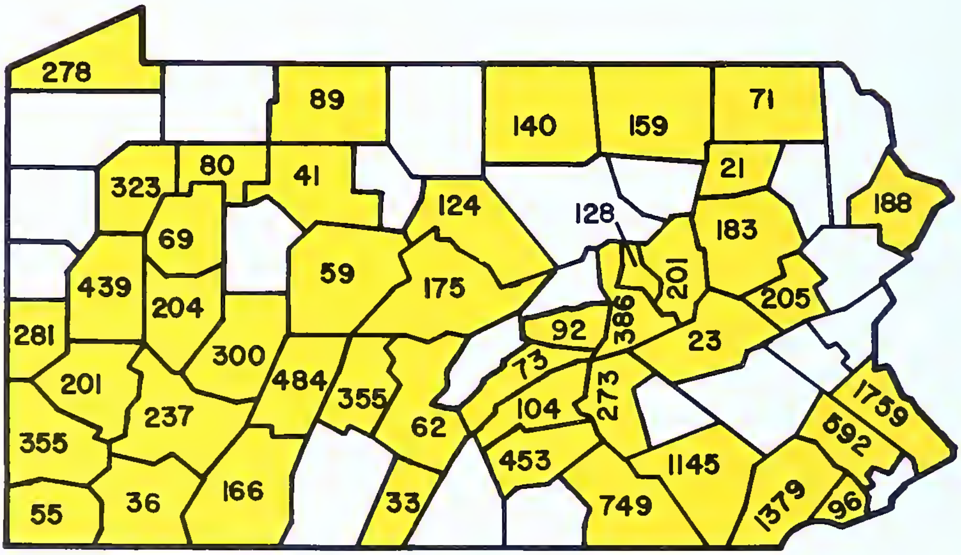
An accuracy code is provided for the well location, depth of the well, altitude of the well at the surface, the water level, and the drawdown when pump tested. The code signifies the relative accuracy of that particular measurement.

Copies of the computer printout sheets are available from the Harrisburg Office at $0.05 per sheet. The wells for each county are grouped by township; the townships are then listed alphabetically. To receive complete information on one well, copies of four printout sheets are necessary. Table 1. lists the number of computer sheets for each county and the total cost. However, when basic information on only one or two wells is desired, a copy of the driller's well completion record can be requested free of charge.

The Pennsylvania Geological Survey has expanded the information on the printouts from that on the well completion cards. The expanded information includes the physiographic province, the basin and sub-basin, the topographic quadrangle, and even the name of the principal aquifer. The Geologic Survey will soon complete a guide to the use of the computer printout. With this, the data retrieval system will be more useful than ever to the citizens of Pennsylvania.

Evan T. Shuster

TABLE 1. INDEX MAP OF COUNTY PRINTOUTS AVAILABLE, NUMBER OF WELLS INVENTORIED, AND COST.



County	No. of Computer Sheets	Total Cost
Adams	NA	
Allegheny	28	$1.40
Armstrong	28	1.40
Beaver	36	1.80
Bedford	NA	
Berks	64	3.20
Blair	48	2.40
Bradford	20	1.00
Bucks	216	10.80
Butler	36	2.80
Cambria	64	3.20
Cameron	NA	
Carbon	28	1.40
Centre	24	1.20
Chester	144	7.20
Clarion	16	.80
Clearfield	12	.60
Clinton	16	.80
Columbia	28	1.40
Crawford	NA	
Cumberland	60	3.00
Dauphin	36	1.80
Delaware	12	1.60
Elk	8	.40
Erie	40	2.00
Fayette	8	.40
Forest	12	.60
Franklin	NA	
Fulton	4	.20
Greene	8	.40
Huntingdon	8	.40
Indiana	36	1.80
Jefferson	NA	
Juniata	12	.60
Lackawanna	NA	
Lancaster	140	$7.00
Lawrence	NA	
Lebanon	NA	
Lehigh	NA	
Luzerne	64	3.20
Lycoming	NA	
McKean	12	.60
Mercer	NA	
Mifflin	NA	
Monroe	NA	
Montgomery	80	4.00
Montour	16	.80
Northampton	NA	
Northumberland	52	2.60
Perry	16	.80
Philadelphia	No Wells	
Pike	24	1.20
Potter	NA	
Schuylkill	4	.20
Snyder	12	.60
Somerset	24	1.20
Sullivan	NA	
Susquehanna	12	.60
Tioga	20	1.00
Union	NA	
Venango	48	2.40
Warren	NA	
Washington	44	2.20
Wayne	NA	
Westmoreland	32	1.60
Wyoming	4	.20
York	100	5.00

STATE GEOLOGIST ON NATIONAL COMMITTEES

State Geologist, Arthur A. Socolow, has been designated to serve another three-year term on the American Commission on Stratigraphic Nomenclature, as official representative of the American Association of State Geologists. Dr. Socolow has been Chairman of the Stratigraphic Commission for the past year.

Dr. Socolow has also been appointed as a geologic member of the U. S. National Committee on Tunneling Technology, a committee of the National Academy of Sciences.

SURVEY ANNOUNCEMENTS

NEW REPORT ON PENNSYLVANIA COAL

The Pennsylvania Geological Survey has released a new report entitled, "Analyses and Measured Sections of Pennsylvania Bituminous Coals", by Robert D. Sponseller. This 478-page publication is particularly timely and relevant to the current energy "crisis" for it gives detailed data on the composition, thickness, and geologic occurrence of bituminous coals of western Pennsylvania. The data in this new report will be of direct use to those who plan and actually initiate production of coal in Pennsylvania.

Bulletin M 66, "Analysis and Measured Sections of Pennsylvania Bituminous Coals", is available for $6.30 plus sales tax from the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

CORE DRILLING PROJECT IN DuBOIS AREA

As part of our current geologic mapping of the DuBois 15-minute quadrangle, the Pennsylvania Geologic Survey has drilled three long core-holes in the area north and west of DuBois. The cores have been logged in detail and completely photographed as a perminant record. All recoverable coals are to be analyzed. The cores penetrate the interval from the Middle Pennsylvanian Allegheny Group to Mississippian and/or Devonian rocks questionably related to the Pocono and/or Catskill Formations.

The following table is a list of pertinant information for each drill hole:

	Drill Hole #1	Drill Hole #2	Drill Hole #3
Location:	41°10′15″N. Lat. 78°46′10″W. Long. 2½ miles NNW of DuBois on State Game Lands No. 77 Sandy Twp., Clearfield Co. Falls Creek 7½ minute quadrangle.	41°12′57″N. Lat. 78°55′08″W. Long. 1¼ miles NW of Allens Mills in Warsaw Twp., Jefferson Co. Hazen 7½ minute quadrangle.	41°07′41″N. Lat. 78°57′33″W. Long. 1 mile ESE of Emerickville in Pinecreek Twp., Jefferson. Hazen 7½ minute quadrangle.
Surface Elevation:	Approximately 1888 ft.	Approximately 1910 ft.	Approximately 1815 ft.

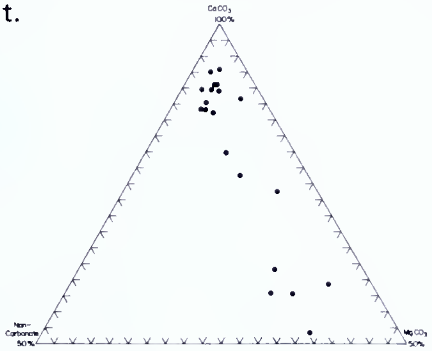
Stratigraphic Interval:	Above Lower Kittanning Coal to Patton Redbeds	Above Upper Kittanning to Patton Redbeds	Above Lower Freeport Coal to Patton Redbeds
Drilling Depth:	511 ft.	702 ft.	891 ft.

Persons desiring a copy of the drilling records, coal analyses, or other information relating to these drill holes should write or call the State Geologist, Pennsylvania Geological Survey, Dept. of Environmental Resources, Harrisburg, Pa., 17120.

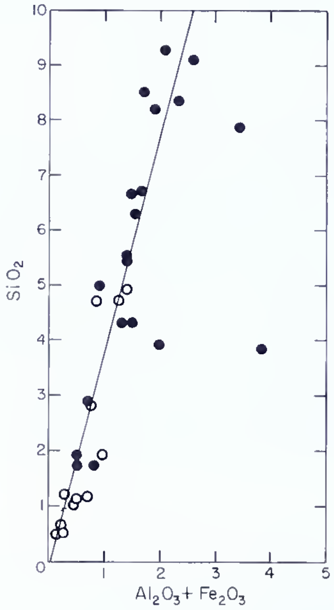
LIMESTONE CHEMISTRY AND ACID INSOLUBLE RESIDUES

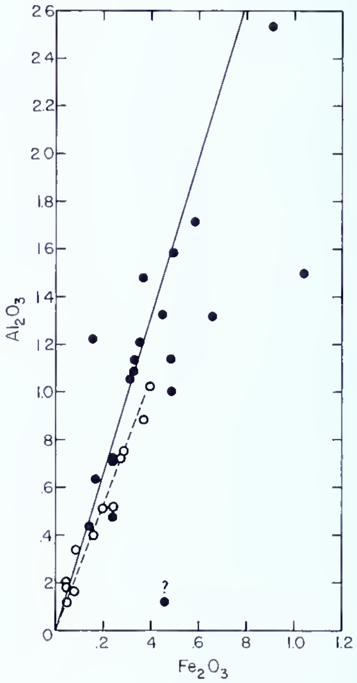
For many years, one aspect of the evaluation of carbonate rocks for their economic utility has involved the study of acid insoluble residues. These residues remain after the carbonate rock has been dissolved in acid. Determination of the amount of acid insoluble residue in carbonate rocks has had its principal use in rapid discrimination between high calcium limestones ($> 95\%$ $CaCO_3$) and less pure limestones. From studies in Franklin and Cumberland counties, we now believe that, in addition to measuring the total non-carbonate component of the rock, a study of the acid insoluble residue fraction of the rock will give an approximation of the chemical composition.

To obtain an acid insoluble residue, a limestone sample is crushed to a fine size, weighed, and digested in hydrochloric acid until all the calcium (and magnesium) carbonate has dissolved. That portion that is insoluble in acid remains as a residue which is then decanted, dried, weighed, and calculated as a percentage of the total sample. Chemical analyses of the rock from two quarries studied here indicate that the acid insoluble residue is normally attributable to the analytical constituents SiO_2, Al_2O_3, and Fe_2O_3 (total iron). Usually P_2O_5 and S are reported in the chemical analyses; because they generally constitute less than 0.05% of the sample, they are disregarded for the procedure discussed here. The SiO_2, Al_2O_3, and Fe_2O_3 represent the clay, quartz silt, and very fine quartz sand washed from the land into a depositional environment analagous to the present-day Bahama carbonate banks. In an area where this terrigenous component is small (15% or less) and is derived from a land mass of somewhat uniform composition, the relative amounts of SiO_2, Al_2O_3, and Fe_2O_3 (total) should be fairly constant.



Twenty analyses from a quarry in the Middle Ordovician limestones of the St. Paul Group in Cumberland County do demonstrate a constant relationship of SiO_2: Al_2O_3: Fe_2O_3 (total). Figure 1 shows the composition of these limestones and indicates that some are dolomitic. A plot of SiO_2 against Al_2O_3+Fe_2O_3 (Figure 2) shows that an approximate linear relationship (visually derived) exists and that from this linearity SiO_2: Al_2O_3+Fe_2O_3 is 3.8:1 a second plot (Figure 3) of Al_2O_3 against Fe_2O_3 also shows a linear relationship from which Al_2O_3: Fe_2O_3 is 3.2:1. This calculation shows that a typical acid insoluble residue sample from the St. Paul Group at this quarry contains SiO_2: Al_2O_3: Fe_2O_3 in the proportion of 12.2:3.2:1 or approximately 12:3:1. Thus, here acid insoluble residues can be used as a measure of the non-carbonate major oxides, from which it is possible to surmise the utility of limestone for industrial or chemical purpose. For example, a limestone which contains 5% acid insoluble residue can be reckoned by this method, to contain approximately 3.70% SiO_2, 0.98% Al_2O_3, and 0.31% Fe_2O_3.





To confirm the validity of these conclusions 12 chemical analyses of high calcium limestone in the St. Paul Group, from a quarry 50 miles southwest at Marion, Franklin County, were plotted as open circles on the graphs. These points lie approximately on the line (Figure 1) for SiO_2: Al_2O_3+Fe_2O_3 confirming this ratio, as well as substantiating the line at small amounts of acid insoluble material. However, these points do not coincide with the line (Figure 3) for Al_2O_3: Fe_2O_3 but rather another line can be approximated (shown dotted) in which Al_2O_3: Fe_2O_3 is 2.7:1. The moderate difference in Al_2O_3: Fe_2O_3 is virtually negligible in chemical analysis. The ratio, here, of SiO_2:

Al_2O_3: Fe_2O_3 is 10.3: 2.7:1 which for a limestone with 5% acid insoluble residue is reckoned to contain approximately 3.70% SiO_2, 0.96% Al_2O_3 and 0.36% Fe_2O_3 which values are in good agreement with those previously derived. The difference in Al_2O_3: Fe_2O_3 between the two quarries may be accounted for by slight compositional differences in the source terrain.

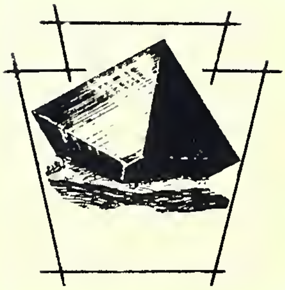
Two factors should be considered which will affect the reliability of these concepts. Secondary silicification, which introduces SiO_2 in the form of chert or quartz rosettes, is a fairly random process in the post-depositional history of the carbonate rocks, and the oxide proportions may vary considerably from those established. Hence, any beds containing chert are suspect and should be sampled with care. Wind-blown quartz grains, although primary in the sense that they accumulated during formations of the limestone, also introduce SiO_2 in a random manner and therefore beds containing visible wind-blown quartz grains are suspect and should be sampled with care. Similarly, laminae of more shaly nature will result in a poor curve or in calculation errors. Weathering will cause the same kind of problems.

As noted previously, the oxide proportions calculated here will vary slightly for various carbonate-rich formations because of differences in land mass composition from which the silt, sand, and clay are derived. This can rapidly be determined by the techniques described here, where abundant reliable chemical analyses are available. The results should be interesting and useful in working out the depositional history of the early Paleozoic in Pennsylvania.

Samuel I. Root
Chief, Field Geology Division

MINERALS ENGINEERS NEEDED

Minerals engineers are sometimes called extractive engineers, or even just mining engineers. Whatever their title, more are needed according to Professor Thomas V. Falkie, chairman of the Department of Mineral Engineering at Pennsylvania State University. He estimates that about twice as many are required by industry as are being graduated from the nation's colleges and universities. For example, students graduating from Penn. State received, on the average, about four job offers each, and a few as many as ten offers. He estimates that about 200 graduates enter the mining engineering field each year, whereas about 400 per year are needed. Furthermore, he believes that in the future this shortage will become worse. This situation in metallics extraction already is grim and the situation in the petroleum and natural gas industry may not be much better. The extraction of metals and mineral fuels such as coal, gas, oil, uranium, iron, silver, copper, and asbestos obviously is a fruitful field for investigation by students. The work not only is interesting but also is important from both economic and environmental standpoints.



EARTH SCIENCE TEACHERS' CORNER

the survey helps high school students

Although our policy always has been to help students with rock, fossil, and mineral identification, during the past year the Survey has given more assistance than usual. No doubt this has happened because the Pennsylvania Geological Survey has become better known and because our new Department of Environmental Resources is having a great impact on our environment, of which geology is an important part.

For the past several years the Survey has been giving a high school student in Harrisburg with field geology, mineralogy, and experimentation concerning Pennsylvania's burning anthracite and culm banks (Pennsylvania Geology, volumes 2/1, 2/5, 2/6, and 3/2). For the second year in a row, Wayne Downey Jr. has won the Grand Championship of the Capitol Area Science Fair with his study of this problem. This year he will travel to San Diego to the national fair and we congratulate him for his earth science studies and for the relevance they have shown to the pollution of our environment.

As a consequence of Wayne Downey's project, the Survey has been able to advise other collectors and students interested in this subject. Among those who contacted us was the Mark T. Sheehan High School in Wallingford, Connecticut. Here, enrichment projects are undertaken as a means of introducing students to the earth sciences as well as to research that requires use of scientific methods. Several projects arising from Mr. Downey's work were suggested and will be incorporated in their program. Among them are the study of crystal growth variations as a result of modification by natural radioactive bombardment, the differences in the conditions for growth of othorhombic and monoclinic sulfur, and the transformation between pairs of hydrous and anhydrous mineral salts, such as gypsum and anhydrite. We not only wish them success in their program of earth science studies, but recommend this approach to high schools in Pennsylvania as excellent scientific training involving relatively simple experimentation.

As a follow-up of Mr. Downey's study, the Pennsylvania Survey will be extending his research. A report on this subject is being prepared by John H. Barnes and Davis M. Lapham with an assist by the U. S. Geological Survey which is performing quantitative chemical analyses of several of the compounds that are believed to represent new minerals. What began as simple assistance by the Pennsylvania Survey has become work of importance both to the science and to the improvement of our life quality. It also has involved many other people and organizations. This is the way of basic scientific research and of scientific service, – a way that we believe is important to each member of our society.

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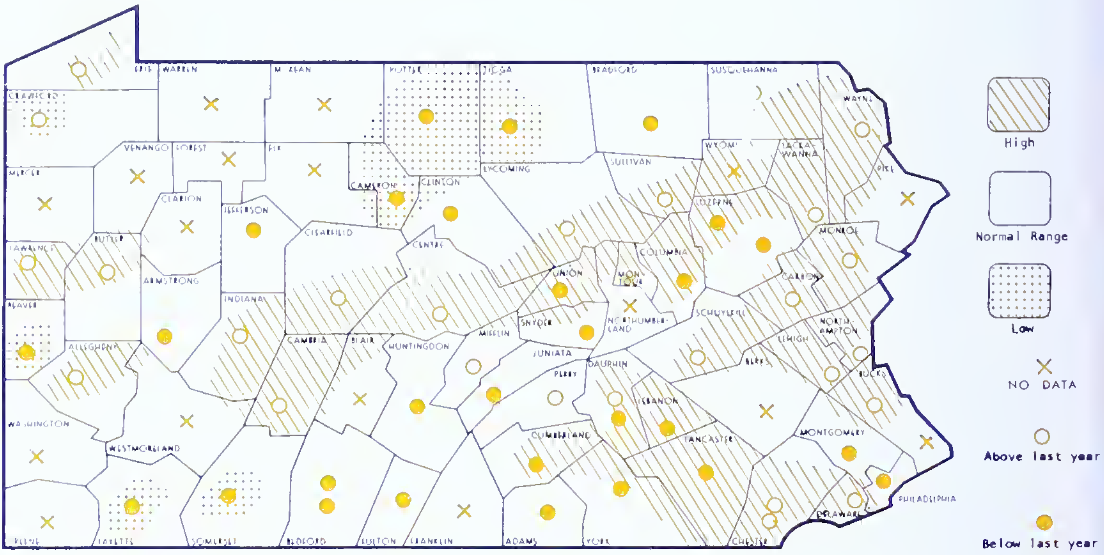
In Cooperation with The U.S. Geological Survey

GROUND WATER DIVISION

In Cooperation with The U.S. Geological Survey

MAY 1973

GROUND-WATER LEVELS



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THE PENNSYLVANIA GEOLOGICAL SURVEY

Vol.

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DEPARTMENT OF ENVIRONMENTAL RESOURCES
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TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Large scale joint block separation in sandstone of the Pocono Formation; Hickory Run State Park, Carbon County. Photo courtesy of William Bolles.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

AUGUST 1973

FROM THE DESK
OF THE
STATE GEOLOGIST...

THERE'S AN EIS IN OUR LIFE — AND YOURS

Since the early 1930's, government agencies and functions have frequently been identified by various combinations of the alphabet. Today, one of the most important activities of the Bureau of Topographic and Geologic Survey and the Department of Environmental Resources is the EIS or Environmental Impact Statement. No major government construction project can proceed in Pennsylvania unless the project designers provide a statement of the impact of the proposed project on the various physical, biological, economic, and social elements of the environment. Then the Environmental Impact Statement (EIS) is reviewed for accuracy and thoroughness by each of several state agencies.

The Pennsylvania Geological Survey has been evaluating as many as 50 EIS's each month. These include projects by the U.S. Army Corps of Engineers, the U.S. Department of Housing and Urban Development (HUD), the Atomic Energy Commission (AEC licensed nuclear generating plants) and, particularly, proposed projects of the Pennsylvania Department of Transportation (PENNDOT). As the Survey's Environmental Geology Division reviews each EIS, we are determined that there should be a clear statement as to what effects the proposed project will have on the geologic environment (might it cause landslides, groundwater pollution, restricted mineral extraction, stream erosion, etc.), and, also, what effects the geologic environment may have on the project (difficult sinkhole condition, mined out voids, costly hard rock excavation, unstable slope formations, availability of construction materials, etc.).

The 40 to 50 EIS reviews which the Survey writes up each month do not show up in the annual list of basic geologic projects cited in the following pages of this bulletin. Yet these EIS reviews are a vital contribution to the preservation of the quality of Pennsylvania's environment, while at the same time forwarning engineers and planners of costly geologic pitfalls.

It is important to note that while EIS write-ups are not usually considered as basic research projects, they require astute, comprehensive geologic expertise and an existing accumulation of geologic data. It is precisely because the Pennsylvania Geological Survey has a long history of geologic mapping and mineral resource investigations that are we now able to provide on short notice the Environmental Impact assessments so important in protecting our environment.

Arthur A. Socolow

GEOLOGICAL RESEARCH IN PENNSYLVANIA
1973

INTRODUCTION

This publication is the sixteenth annual report on Geological Research and Publications in Pennsylvania. No report was issued in 1972 because the flood of June 1972 destroyed all of the typed copy and original data for that year's report. Thus there was no convenient way to regenerate the data. We decided, thus, to eliminate the 1972 report because of the problems of recovering from the flood and combine it with 1973 data. The data on geological research reports and in-press reports represent current work. The list of published reports since June 1971 is so extensive we do not have room to publish it.

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Publications in press are listed by author.

As with all compilations, there are omissions. This is unintentional. Additional copies can be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, Pennsylvania 17120.

RESEARCH IN PROGRESS

AREAL GEOLOGY

HAROLD H. ARNDT, U.S. Geological Survey. Western Middle Anthracite Field. Geology of the Shenandoah and Delano 7½-minute quadrangles will be combined with a previously planned report on the Ashland, Mt. Carmel and south half of the Shamokin quadrangles. Work continues on the preparation of final summary report, "Geology of the Western Middle Anthracite field and adjoining areas, Pa."

T. M. BERG, Pa. Geological Survey, Geology and Mineral Resources of the Brodheadsville 7½-minute quadrangle, Monroe County, Pa. Publication will include geologic maps of bedrock and surficial deposits. A fracture trace map will also be included. Stratigraphic units and surficial deposits are described in terms of detailed lithology, field occurrence and exposed sections, origin, ground-water potential, mineral resources, engineering characteristics, and geologic hazards. A complete discussion of the structural geology is included. Maps of this area are on open file at the offices of the Pa. Geological Survey in Harrisburg.

M. J. BERGIN, U.S. Geological Survey. Northern Anthracite Field. Geologic studies, including field checking and revision of mapping, continue in the Kingston, Pittston, Wilkes-Barre East 7½-minute quadrangles. Resumption of geologic mapping is planned in the Nanticoke quadrangle.

AVERY A. DRAKE, JR., U.S. Geological Survey. Geology of Allentown quadrangle and vicinity. Objectives: To decipher the tectonic history of the area with special emphasis on the emplacement of gravity slides, Alpine nappes, and thrust sheets as well as the mechanics of multiple deformation. It is planned to complete a cross section across the central Appalachians by tying on the ground work in the Anthracite region and along strike with that of the Pa. Geological Survey in the Reading area. Field work is complete in the Hellertown, Allentown East, and Catasauqua quadrangles and has been started in Clementon, Slatedale, New Tripoli and Topton quadrangles. Field work is temporarily recessed while Drake is involved in the design of the Interior Department's R.A.L.I. program.

JACK B. EPSTEIN, U.S. Geological Survey, W. D. SEVON and J. D. GLAESER, Pa. Geological Survey, and G. G. CONNALLY, SUNY at Buffalo. Wind Gap Area, Pa. Mapping in Saylorsburg, Wind Gap, Kunkletown, Palmerton, and Lehighton quadrangles. Studying the stratigraphy, sedimentation, structure, geomorphology, glacial geology, economic geology, and environmental geology of Ordovician-Devonian and Pleistocene sediments. Studies on the origin of cleavage. Topical studies in the western part of the Hamburg klippe of Pa.

ROBERT T. FAILL and RICHARD B. WELLS, Pa. Geological Survey. Geology of the southern half of the Warrensville and the northern half of the Milton quadrangles. Project involves a geologic map, with a brief, descriptive text on the stratigraphy, structure, environmental geology and mineral resources.

G. B. GLASS, Wyo. Geological Survey, WILLIAM E. EDMUNDS and J. DOUGLAS GLAESER, Pa. Geological Survey, and VINCENT C. SHEPPS. Geology and Mineral Resources of the southern Houtzdale quadrangle.

ALBERT D. GLOVER and WILLIAM A. BRAGONIER, Pa. Geological Survey. Geology and Mineral Resources of the DuBois 15 -minute quadrangle. Study involves geologic mapping of bedrock and surficial material. Report will include a discussion of the stratigraphy, structure, mineral resources and environmental aspects of the area. Field work is completed and the report is in preparation.

ALBERT D. GLOVER and JOHN H. WAY, JR., Pa. Geological Survey. Geology and Mineral Resources of the Altoona 15-minute quadrangle. The study involves geologic mapping of bedrock and surficial material. Hydrology, (by Ed Meiser at The Pennsylvania State University) mineral resources, and environmental aspects of the area will be incorporated in a report due to be completed late in 1975.

DONALD M. HOSKINS, Pa. Geological Survey. Geology and Mineral Resources of the Millersburg quadrangle. Work was stopped due to the destruction of all notebooks and aerial photographs by the June 1972 flood. Compilation maps with all structural data were saved and are the basis for resumption of the work.

DAVIS M. LAPHAM, Pa. Geological Survey. Serpentinites of Lancaster County. Structure, lithology, petrology, mineralogy, geochemistry, and economic geology of the serpentinites and associated metasediments of southern Lancaster County.

DAVID B. MACLACHLAN, Pa. Geological Survey. Geology of the Reading 15-minute quadrangle. Investigation to date has primarily been directed to several parautochthonous slices of lower Paleozoic rocks and their relationship to the termination of the Reading Prong of Precambrian crystalline rocks. Reconnaissance, especially by Alterman and Myers, indicates a substantial proportion of allochthonous clastics in the northern part of the area. Less intensely deformed Triassic rocks in the southern part of the area will be included in the final report.

LUCIAN B. PLATT, Bryn Mawr College. Allochthonous Blocks in Martinsburg Shale. Large and small blocks of various rock types are recognized as arriving in the Martinsburg Shale during the time of deposition of that unit. Mapping in the Great Valley aims at determining the extent and stratigraphic relations of the allochthonous rocks.

SAMUEL I. ROOT, Pa. Geological Survey. Geology and Mineral Resources of the Harrisburg West Area. Mapping completed in the Harrisburg West area. Four periods of deformation recognized.

S. P. SCHWEINFURTH, U.S. Geological Survey. Claysville-Avella Project. This project is to map geologically two 7½-minute quadrangles and parts of two others that join on the west; to evaluate coal and other mineral resources and to gather and evaluate data that will aid in understanding the depositional framework of the Upper- Pennsylvanian-Lower Permian of the northern part of the Dunkard Basin, its structural history and the paleogeographic controls of coal accumulation and quality.

W. D. SEVON and T. M. BERG, Pa. Geological Survey. Geology and Mineral Resources of the southern half of the Pocono 15-minute quadrangle, Pa. Field work for this mapping project is approximately three-quarters completed.

WALTER R. WAGNER, JESSE CRAFT, LOUIS HEYMAN and W.S. LYTLE, Pa. Geological Survey. Revising Geologic Maps of Greater Pittsburgh Urban Area. Published geologic maps (1:62,500) are being updated by transferring selected information and group boundaries to 1:24,000 topographic quadrangles. The contacts are checked by subsurface data and by coal and limestone mining. Northern Butler County structure maps on the Vanport limestone are being revised.

G. H. WOOD, JR., U.S. Geological Survey. Drainage of Pa. Anthracite Mines. Geologic data on the structure, stratigraphy, mining, and resources of specified areas in the Pa. anthracite region as required by the U.S. and Pa. Bureaus of Mines.

G. H. WOOD, JR., U.S. Geological Survey. Southern Anthracite Field. Field work is continuing in the area of the Weatherly 7½-minute quadrangle, and mapping of the Nesquehoning 7½-minute quadrangle is near completion. The mining and geologic data will be incorporated into geologic quadrangle maps at 1:24,000 scale and coal maps at 1:12,000 scale.

ECONOMIC GEOLOGY

JACOB FREEDMAN and various students, Franklin and Marshall College. Geochemical Exploration for Nickel in the Mine Ridge Anticline. Intermittently collecting water, stream sediment and soil samples for AAS analysis for Ni, Cu, Co, V, and Mn. Aim is to find deposits of ore similar to that in the Gap Nickel Mine.

JOHN C. GRIFFITHS, The Pa. State University. Value of Mineral Resources of Pa.

JOHN. W. HOSTERMAN, U.S. Geological Survey. Clay Studies in Pa.

WILLIAM S. LYTLE, J. CRAFT, L. HEYMAN and W. WAGNER, Pa. Geological Survey. Oil and Gas Map of the Greater Pittsburgh Urban Area. Compilation of a map, 1:125,000 scale, showing the oil and gas fields. Where possible, map will show the abandoned fields, the dry holes outside the fields, and the location of a well in the field for which the Survey has a record showing the stratigraphy.

BERNARD J. O'NEILL, JR., Pa. Geological Survey. Sources of Sand and Gravel and Other Construction Aggregates within the Greater Pittsburgh Urban Area. The purposes of this investigation are to identify the following: (1) locations of active producers of sand and gravel and other construction aggregates, (2) areas where the geological conditions are considered favorable for exploration to develop additional sources of these mineral commodities.

BERNARD J. O'NEILL, JR., DAVIS M. LAPHAM, and JOHN H. BARNES, Pa. Geological Survey, and U.S. BUREAU OF MINES. Properties and Uses of Pa. Shales and Clays. This regional study is the third in a series started in 1962 to evaluate the economic potential of shales and clays. Tests on samples collected from various intervals in the stratigraphic column will determine their fired and unfired properties, chemical content, and mineralogy. The results of these tests will be used to determine use patterns, and to identify variables for predicting the uses for such raw materials.

ROBERT C. SMITH, II, Pa. Geological Survey. Lead and Zinc Occurrences of Pa. An attempt is being made to locate each sphalerite and/or galena occurrence in Pa., map the accessible mines or outcrops, and describe the relation of mineralization to geology. Representative samples will be collected for trace element analyses of pure mineral separates. The mineral trace element data will be considered in terms of health hazard, economic recovery, geochemical exploration, classification and genesis.

ENGINEERING GEOLOGY

NORMAN K. FLINT, HEINZ DEHN and HAMEED ELNAGGAR, University of Pittsburgh. Slope Stability Studies in Southwestern Pa.

B.H. KENT, U.S. Geological Survey. Geologic Factors in Coal-Mine Roof Falls, Pa. and W.Va. Compilation of isopach maps of overburden thickness on Pittsburgh coal is nearing completion. Regional and local structure-contour maps of the Pittsburgh coal bed, a regional isopach map of overlying Pittsburgh sandstone, and local isopach maps of main seam thickness and of the interval from the top of the main seam to the base of the Pittsburgh sandstone have been completed.

L. KIRKALDIE, T. DUMPER and J. VAN, U.S. Department of Agriculture, Soil Conservation Service. Rock Weathering Beneath Glacial Deposits.

L. KIRKALDIE, T. DUMPER and J. VAN, U.S. Department of Agriculture, Soil Conservation Service. Short Term Weathering Characteristics of Pennsylvanian Shales.

MARC SBAR, ALBERT J. DEPMAN and DANIEL G. PARRILLO, U.S. Army Corps of Engineers, Philadelphia. Natural Seismicity in the Vicinity of the Delaware Water Gap National Recreation Area. Project will study the natural background seismicity in the proposed Tocks Island Lake area with a network of permanent recording stations and continue monitoring all seismic events during construction, initial spillway and normal operation of the proposed reservoir. Results of this pilot program, in what is regarded as a nonseismic area, will indicate the advisability of future installation and any need to revise present seismic design criteria.

ENVIRONMENTAL GEOLOGY

GEORGE L. BAIN, U.S. Geological Survey. Feasibility of East Coast Triassic Basins for Waste Storage. (Information on open file.)

R. P. BRIGGS, U.S. Geological Survey. Greater Pittsburgh Regional Studies. Reports on flood-plain mapping and on recent and historic floods are soon to be distributed. Distribution of a mineral field investigation map showing the nature of roof rock and jointing of roof rock in the Pittsburgh coal and a guide to large-scale geologic maps is also planned. Two geologic maps will be forthcoming. Overdip slope maps for Allegheny, Armstrong, and Beaver Counties will be distributed and are in preparation for Butler, Washington and Westmoreland Counties.

JESSE L. CRAFT, Pennsylvania Geological Survey. Overburden Thickness Map of Greater Pittsburgh Urban Area. Map to show thickness of rock above the Pittsburgh coal to be published at a scale of 1:125,000. Phase I will consist of Washington, Allegheny and Butler Counties, completed July 1, 1973. Phase II will consist of Beaver, Armstrong and Westmoreland Counties, and will be completed by Dec. 30, 1973.

HARRY CROUSE and ARTHUR W. ROSE, The Pa. State University. Coal Resources and Acid Mine Drainage, Pine Creek Drainage Basin. Project involves mapping the extent of coals in the basin, collecting data on thickness of coal and investigating the reactions of acid mine drainage with stream sediments.

GROVER H. EMRICH and DONALD BATIPPS, A. W. Martin Associates, Inc. Sediment Runoff from Highway Construction and Effect on Public Water Supply Reservoir. A three-year study will be conducted to determine the normal sediment runoff into a public surface-water reservoir and then monitor changes in this sediment runoff with phases of construction of an Interstate highway.

GROVER H. EMRICH and ARTHUR RUSSNOW, A. W. Martin Associates, Inc. Environmental Impact of Proposed Highway Construction. A detailed study of the hydrogeology influencing the movement of ground water, including definition of specific recharge areas in Hollidaysburg area, Pa. Once the ground water, surface water system is defined, the impact of proposed highway constuction will be determined.

GROVER H. EMRICH, A. W. Martin Associates, Inc., and DAVE WITWER, Pennypack Watershed Assn. Land and Water Management in the Pennypack Creek Basin. Evaluation of three square miles of the Pennypack Watershed based on soils, slope, geology and ground-water and surface-water conditions. To define areas for management as a resource corridor by the Pennypack Watershed Assn. Definition of areas for spray irrigation and design of system for treatment of sewage and its application by spray irrigation for management of surface and ground water within the basin.

JACOB FREEDMAN and various students, Franklin and Marshall College. Relationship of Incidence of Cancer to Rock in Vicinity of Homes of Patients. "Does the underlying rock, the soil in it, and the water passing through it have a carcinogenic effect on the endemic population?" With cooperation of the local offices of the American Cancer Society, home addresses of past and present cancer patients are plotted on (Lancaster and Lebanon) County maps. If concentrations develop, trace element investigations of the area's rocks, soils, and water will be checked for possible carcinogenic trace elements.

MARY E. HORNE, General Analytics, Inc. Environmental Geology of the York Area.

S. G. KHOURY and HENRY L. POLLAK, University of Pittsburgh. Quantitative Geology and its Environmental Applications. The available structural contour maps on the base of shallow subsurface marker horizons in the Appalachian Plateau are not reliable estimates of the actual structure. Besides being subjective, the resulting maps do not recognize the complexity of the signal at each datum point. Modern electronic computer techniques permit solution of these problems with much precision. The resulting models can not only predict a likely condition but will also estimate the error involved in such a prediction. The models can predict the orientation of joints, the flow of underground water, the risk of mine subsidence, etc.

EDWIN F. KOPPE, Consulting Geologist, and D. R. THOMPSON, Pa. Department of Environmental Resources. Progress in the Recognition of Rock Zones in Prevention and Abatement of Mine Drainage in Lackawanna and Clearfield Counties. Studies of linear features and fracture traces lead to improved techniques in the prevention and abatement of mine drainage from deep coal mines. An example in Lackawanna County proposes a flume to reduce quantities of surface water entering abandoned mine workings. Examples from Clearfield County illustrate relocation of boreholes and proposed mine seals to assure integrity when mines are abandoned, sealed and flooded. Plans for new mines also are modified to intercept fracture traces at angles designed to provide roof control for added safety and to reduce water quantities entering the mines.

JOHN OSGOOD (Task Manager), Pa. Department of Environmental Resources, Bureau of Water Quality Management. Ground-Water Quality of the Erie Basin. An examination of the ground-water characteristics of the Erie Basin with special emphasis on the physical properties, ground-water quality and quantity, waste disposal practices, polluted areas, and future resource management procedures. A portion of the Comprehensive Waste and Water Quality Management Study of the Pa. Area of the Erie Basin and the Erie Standard Metropolitan Statistical Area.

GENERAL GEOLOGY

ERNST CLOOS, Johns Hopkins University. Geology of the Thomasville Limestone Deposit. The limestone deposit at Thomasville is unique and of more than local interest. A thorough study has been underway since 1937 and it is planned to make the general data available to others.

JOHN A. ENMAN, Bloomsburg State College. Production of Color Slides of Pa. Landscapes and Formations and Collection of Rocks and Minerals for International Exchange. I am producing a set of 2 x 2 inch color slides of Pa. landscapes and geological formations and collecting museum type specimens of Pa. rocks and minerals to be exchanged for like minerals supplied by the Department of Geology and Mines, Government of Rajasthan, Udaipur, India.

ALAN R. GEYER, Pa. Geological Survey, and WILLIAM BOLLES, Pennsylvania Department of Education. Guide to the Geology of Interstate 80. A general guide stressing significant geologic points of interest for the local as well as long-distance traveler.

RICHARD NICKELSEN and various students, Bucknell University. Geologic Mapping — Bedrock of Buffalo Valley, Lewisburg quadrangle.

K. C. ROBERTS and R. D. SHACKLETON, Medusa Cement Company. Geology of Carlisle Clay, Inc. Clay Pit, Toland, Pa. Various papers have been published concerning the origin and structure of the white clay at the Carlisle Clay, Inc. (formerly Philadelphia Clay Co.) clay pit at the base of South Mt. near Mr. Holly Springs, Pennsylvania. We have done three separate drilling programs and a substantial amount of chemical work on the clay seam. Extensive mapping has also been performed. Our opinion as to the structure of the clay deposit and the origin of the clay will be discussed along with the results of the drilling.

GEOCHEMISTRY

MARIA LUISA CRAWFORD and various students, Bryn Mawr College. Chemical Analysis of Piedmont Crystalline Rocks.

BRUNO J. GILETTI, A. W. HOFMANN and J. W. MAHONEY, JR., Brown University. K-Ar and Rb-Sr Data on the Detrital and Postdepositional History of Pennsylvanian Clays from Ohio and Pa.

FU TZU HSU and ARTHUR W. ROSE, The Pa. State University. Stream Sediments and Waters in Northwestern Nittany Valley and Vicinity. Stream sediments have been analyzed for Zn, Pb, Ni, Cu, Mn and Ba and stream and well waters for fluoride. Several anomalous localities have been recognized.

DAVIS M. LAPHAM, Pa. Geological Survey. Geochronology of Core from Erie County Basement. Correlation and significance of K-Ar and Rb-Sr age dates on Precambrian metasediments from drill cores beneath the Plateau.

DALE M. LEWIS and KARL K. TUREKIAN, Yale University. Geochemical study of the Susquehanna River as a Transport Medium of Elements as Dissolved Species and Solids.

JAMES MCNEAL and ARTHUR W. ROSE, The Pa. State University. Geochemistry of Mercury in Rocks, Stream Sediments and Soils of Pa. Rocks of Pa. average lower in Hg than most values in the literature, probably because literature values are largely near ore deposits. Soils and stream sediments contain far more mercury than rocks, probably because of absorption of atmospheric Hg by organic material and clay. The added mercury may result largely from human activities.

DENNIS PENNINGTON and ARTHUR W. ROSE, The Pa. State University. Use of Soil Geochemistry to Prospect for Chromite Deposits in the State Line District, Southern Lancaster County. Soils adjacent to two old chromite mines are strongly anomalous in chromium and nickel. The anomalies appear to be of natural origin. The trend of the ore bearing zones can be identified. We hope the method will be useful in finding additional chromite ore bodies.

ROBERT C. SMITH, II, A. MONTGOMERY, N H. SUHR and J. B. BODKIN. The Chemical Composition of Chevkinite from Pa. The chemical composition of chevkinite, a rare earth titanosilicate from Bethlehem, Northampton County, Pa., is being determined by instrumental procedures. The chevkinite occurs as crystals in a hornblende-bearing pegmatite which contains traces of zircon and molybdenite with 2H:3R approximately 10:1. From the U, Th, and Pb contents, an age of 916+50 m.y. has been calculated. X-ray fluorescence, instrumental neutron activation analysis, and emission spectroscopy are being compared for the lanthanide analyses. To date, 34 components have been quantitatively determined.

R. W. WHITE, U.S. Geological Survey. Dispersion of Elements in the Zone of Weathering. Sample collection of fresh and weathered granitic and basaltic rocks and derived soils from 5 different climatic zones is continuing to determine their mineralogy and petrography. Samples from various areas will be prepared and submitted in a random sequence for analysis.

E. ZEN, U.S. Geological Survey. Low Temperature Mineral Equilibria. This continuing investigation includes studying and reporting on the petrology of metamorphic and sedimentary rocks, the thermodynamic properties of rock-forming minerals, general problems of near-surface gravity tectonics, and the geologic history, stratigraphy and metamorphism of the western part of the northern Appalachian orogen.

GEOMORPHOLOGY

NOEL POTTER, JR., Dickinson College. Distribution of Karst Depressions in Cumberland County, Pa.

DALE F. RITTER, Southern Illinois University, and W. FRED KINSEY and MARVIN E. KAUFFMAN, Franklin and Marshall College. Rates of Flood Plain Construction along the Delaware River near Bushkill, Pa.

GEOPHYSICS

WILLIAM A. CRAWFORD and J. H. KALMBACH, Bryn Mawr College. Magnetometer and Gravimeter Survey and Trace Element Trends of Honeybrook Anorthosite in the Wagontown Quadrangle.

B. F. HOWELL, JR. and THOMAS SHULTZ, The Pa. State University. Seismic Hazard in the United States. Average regional seismic hazard index (ARSHI), a newly developed measure of relative hazard from earthquakes, is being used to compare expected hazard from future earthquakes in different locations and is being correlated with different geologic features in a search for the causes of earthquakes in eastern U.S.

M. F. KANE, U.S. Geological Survey. National Aeromagnetic Survey. Approximately 23,000 square miles will be aeromagnetically surveyed this year in Pa. which will complete mapping of the State and permit preparation of 1:1,000,000 scale aeromagnetic maps.

PETER M. LAVIN and JOHN CHEWNING, The Pa. State University. Aeromagnetic Studies in Pa. Determination of the variation in thickness of the sedimentary rocks of western Pa. through spectral analysis of aeromagnetic data. Results will be interpreted in terms of the known regional geology in an attempt to predict the location of economic mineral deposits.

A. J. NAVAZIO, Aero Service Corporation. Digitizing and Computer Interpretation., In 1962, Aero Service flew an aeromagnetic survey covering 130,000 square miles of the Appalachian Basin, including Pa. During 1972, a large portion of the data was digitized and a new interpretation developed using the Computer based Werner deconvolution technique. The results of the study reveal many prospective areas for gas and oil exploration. At this time, almost all of the Pa. data is in digital form, has second derivation maps to accompany it, and has been reinterpreted by computer techniques.

MARC L. SBAR and LYNN R. SYKES, Columbia University. Study of Seismicity in the Vicinity of the Proposed Tocks Island Lake.

JOHN R. SUMNER, Lehigh University. Regional Gravity Surveys. Interpretation of gravity surveys over the Reading Prong of central-eastern Pa. show the dip of the Precambrian gneiss-Paleozoic carbonate interface varies appreciably with locale. Density variations complicate interpretation, but model geologic sections constructed from gravity and suface geology show that gneiss bodies are up to 700 meters thick with steeply or shallowly dipping sides.

GLACIAL GEOLOGY

G. GORDON CONNALLY, SUNY at Buffalo. Surficial Geology and Pleistocene Stratigraphy of the Bangor Quadrangle. Reconnaissance mapping in the Bangor quadrangle indicates that at least five tills are present: three Wisconsinian, one Illinoian, and one pre-Illinoian. The Terminal Moraine, or Bangor moraine, loses its identity within the quadrangle, which has resulted in difficulty in locating the Wisconsinan terminus. The ice margin will be approximated by detailed mapping of soil horizons across the quadrangle.

G. GORDON CONNALLY, SUNY at Buffalo, JACK B. EPSTEIN, U.S. Geological Survey, and LESLIE A. SIRKIN, Adelphi University. Deglaciation of the Wind-Gap-to-Water Gap area. Seven sequences of glacial deposits have been delineated and from these we have mapped seven successive ice marginal positions. Sequences consist of ice-contact, outwash, alluvial, and lacustrine deposits. Four tills are present in the area, one of which is probably pre-Woodfordian. The Wigwam Creek bog has been cored and is being analyzed for the pollen record. A sample from this core has been submitted to the U.S. G.S. for radiocarbon dating.

G. GORDON CONNALY, SUNY at Buffalo, and RAYMOND W. GRANT, Lafayette College. Definition of the Illinoian Formations of the Lehigh Valley. The Illinoian and pre-Illinoian formations of the Lehigh Valley will be described and named as will the soils and paleosols present on these deposits. Field studies are supported by heavy mineral and clay studies of tills and soils.

G. H. CROWL, Ohio Wesleyan University. Late Wisconsinan Glacial Border, North-Central Pa. The Late Wisconsinan glacial border has been traced from the Lehigh River near White Haven to the Appalachian Front north of Benton. Mapping by Lewis and Leverett has been revised. Areas of Early Wisconsinan and Illinoian drifts beyond this border have been noted. The work is partially completed from Benton west to the Loyalsock north of Montoursville.

DENIS E. MARCHAND, Bucknell University. Pleistocene Geology of the Central Susquehanna Basin. Reconnaissance field observations and detailed mapping of local areas along the Susquehanna River's West and North Branches above Selinsgrove reveal a long and complex Pleistocene history. Pre-Wisconsinan glaciation is represented by till, ice contact deposits, fluvial sands, colluvium, and minor loess. Efforts to establish the existence or nonexistence of multiple Pre-Wisconsinan glaciation in this area have thus far been unsuccessful. North of Lewisburg, all or part of the Susquehanna River was diverted westward by Pre-Wisconsinan ice into the Buffalo Valley and possibly into Penns Creek. Wisconsinan deposits mapped outside the terminal moraine include loess, eolian sand, thin colluvium, and outwash or periglacial alluvium deposited on at least five terraces. The 120-130-foot outwash terrace appears to correlate with the Wisconsinan terminal moraine at Berwick.

HYDROLOGY

RICHARD M. FOOSE, Amherst College. Characteristics of Porosity, Permeability, Ground Water Storage, Movement and Yield in the Carbonate Rocks of the Hershey Valley. Through a series of pump tests and the measurement of more than 25 points of observation on a two-week time period, and 6 points of observation by continuous recording, an understanding of all the parameters that affect the behavior of water in several carbonate formations (Ordovician age) is being developed.

JERRALD HOLLOWELL, Susquehanna River Basin Commission. Hydrology of the Abandoned Coal Mines in the Wyoming Valley, Pa. To determine what measures are required to provide a better quality mine discharge in the Wyoming Valley, mine hydrology and mine water quality are related to mine-pool management. The addition of mine-pool outlets at several critical locations will reduce interpool flow and increase the rate of discharge, which would reduce the total mineral load discharged to the river. Additional outlets will act as relief overflows to reduce the maximum fluctuation of mine-pool levels.

CHARLES W. POTH, U.S. Geological Survey. Summary Ground-Water Resources of Erie, Lancaster and Mercer Counties, Pennsylvania.

EVAN T. SHUSTER, Pa. Geological Survey. Hydrogeology of the DuBois Area, Jefferson and Clearfield Counties.

CHARLES R. WOOD, U.S. Geological Survey, and DAVID B. MACLACHLAN, Pa. Geological Survey. Geology and Hydrology of Northern Berks County.

IGNEOUS AND METAMORPHIC PETROLOGY

D. BASU, Lehigh University. Genesis of the Grace Mine Magnetite Deposit, Morgantown, Berks County, Pennsylvania. The purpose of the project is to study the genesis of the magnetite deposit at the Grace Mine and to compare the results with those obtained by other workers on other deposits of similar nature. Mainly petrographic and ore microscopic analysis, X-ray diffraction method and electron microprobe analysis. Specimens have been collected in the form of drill cores that go through the diabase in one direction and through the ore zone in the other. Preliminary petrographic and ore-microscopic investigations on the ore zone as well as on the diabase have been completed. The thermal conditions of the ore zone will probably be revealed in great detail as the work progresses and will be reported later. Finally an attempt will be made in establishing the genetic relationship between the diabase body and the ore body on the basis of detailed microscopic and electron microprobe analytical investigations.

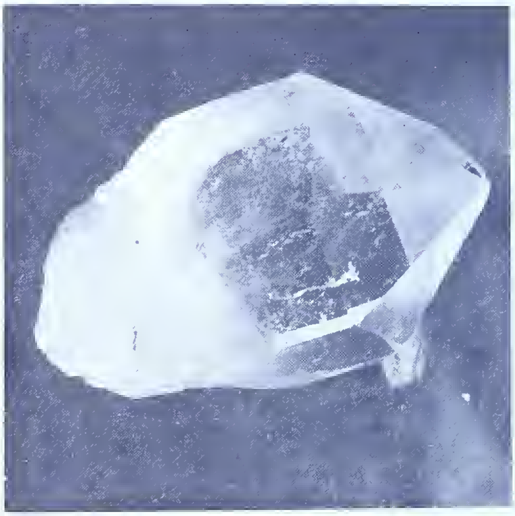
MARIA LUISA CRAWFORD, Bryn Mawr College. Mapping in the Coatesville Quadrangle.

AVERY A. DRAKE, JR. and ROBERT I. TILLING, U.S. Geological Survey. Petrochemistry of the Precambrian Rocks of the Reading Prong of Pa., N.J. and N. Y. The petrochemistry of the rocks of the Reading Prong is being studied by the collection of samples of all rock types from areas that have been adequately mapped. In addition, the radiogenic heat producing minerals of these rocks will be studied to gain a greater insight into heat flow in this tectonic terrain. Analyses for U, Th, and K have been received for the first batch of samples. A preliminary study suggests that the hornblende granite-alaskite suite of N. J. has relatively high heat productivity values and that other metasedimentary-metavolcanic rocks have unusual Th/U values.

JOHN L. FAUTH, SUNY College at Cortland. Possible Devitrified Precambrian Welded Tuffs, Blue Ridge Province, Md. and Pa.

WILLIAM R. PARROTT, JR., Bryn Mawr College. Precambrian Geology, Ridley Creek Area, Delaware County, Pa. The area between U.S. Routes 1 and 3 in the Media 7½-minute quadrangle, originally mapped by Bascom et al. (1909) and Bascom and Stose (1932) as Precambrian gneiss and gabbro, is being reexamined in detail. Results thus far indicate the rocks to be a complex of amphibolites, gneisses of primarily sedimentary origin, and various smaller gabbroic masses, all of which have been metamorphosed to amphibolite to granulite facies and partially migmatized. Age and structural relationships remain uncertain.

CHARLES F. SUTPHEN, Temple University. Petrogenetic Analysis of a Diabase Intrusion. This will consist of a complete chemical and physical analysis of a Triassic diabase dike which is an extension of the dike systems of southeastern Pa.



MINERALOGY

JOHN H. BARNES and DAVIS M. LAPHAM, Pa. Geological Survey, and WAYNE F. DOWNEY, JR. Mineralogy Associated with Burning Anthracite Deposits. A report on minerals forming from sublimation of gases produced by subsurface fires in anthracite mines and culm banks in Luzerne, Schuylkill, and northern Dauphin Counties.

G. W. BRINDLEY, The Pa. State University. Clay Mineralogy Study. Various aspects of clay mineralogy are being studied, including: (1) Adsorption of organic materials by clays, the formation of clay-organic complexes, swelling properties of clay-organic complexes. (2) Mixed-cation montmorillonites and their swelling behavior in water. (3) The formation of long-spacing complexes, particularly by chlorites. (4) The nature of nickel hydrous silicates, particularly garnierites.

RAYMOND W. GRANT and ARTHUR MONTGOMERY, Lafayette College. Investigation of Pa. Minerals. Investigation of both older occurrences where data are incomplete, and new occurrences of minerals, new to the State. We are interested in their descriptive mineralogy, geochemistry, and manner of occurrence as keys to their regional relationships and geological origin. This research began in the fifties and data on it have been published monthly since November, 1962, in a column "Pa. Minerals" in the *Keystone*

Newsletter of the Mineralogical Society of Pa. Part of this project has been updating of Gordon's *Mineralogy of Pa.*, 1922. It has been closely coordinated at all times with similar research by mineralogists of the Pa. Geological Survey under the leadership of Dr. Davis M. Lapham, Chief Survey Mineralogist.

DAVIS M. LAPHAM, Pa. Geological Survey. Mineralogy of Limonite Pseudomorphs, Lancaster County. The mineralogy, geochemistry and geologic occurrence of limonite pseudomorphs from Columbia, Lancaster County, including some experimental work on ion diffusion.

DAVIS M. LAPHAM and JOHN H. BARNES, Pa. Geological Survey. Mineral Collecting in Pa. A revision and updating of Pa. Geological Survey publication G 33, *Mineral Collecting in Pennsylvania*, to include additional topics and new localities with revised mineralogy and geology.

PALEONTOLOGY

JAMES A. BARLOW, WILLIAM C. DARRAH and ROBERT S. REPPERT, W. Va. Geological Survey. Plant Fossils from the Cassville Shale. Recent paleobotanical collections made in active strip mines in the Morgantown, W. Va.-Mt. Morris, Pa. area have yielded some remarkable new plants in addition to the common forms, and have also revealed the existence of two basic paleobotanical facies in this area. These facies are apparently separated geographically, north from south, the northern one being essentially a *Neuropteris* facies, and the southern one a *Pecopteris* facies. These plants support a Permian age for the Dunkard and also substantiate many of the other geological and paleontological observations made by Fontaine and White in 1880 (Pa. 2nd Geol. Survey, v.PP).

BRUCE M. BELL, N.Y. Geological Survey. A Study of North American Edrioasteroidea. In this large monograph, Bell has described one edrioasteroid from the lower Keyser (Upper Silurian) at Hinman, Pa. This study will serve as the definitive work on this extinct class of the Echinodermata. It will appear as a N.Y. State Museum and Science Service Memoir.

T.M. BERG, Pa. Geological Survey. Pelecypod Burrows in the Basal Sandstone Member of the Catskill Formation, Northeastern Pa. Large burrows made by the pelecypod *Archanodon* sp. have been recognized in the basal sandstone member of the Catskill Formation in northeastern Pa. These burrows display specific vectorial features which bear some similarities to approximately homeomorphic pelecypods living in the American northwest Pacific coastal regions. The observed similarities amplify the interpretation that the basal Catskill member is either a delta front or lower delta plain deposit.

T. M. BERG, Pennsylvania Geological Survey. Pa. Geological Survey Paleontological Collections. The Pennsylvania Survey paleontological collections were being organized when the June, 1972 flood hit the Survey. The collections suffered considerable damage and loss, particularly to the Devonian and Lower Paleozoic materials. The Carboniferous materials were not so severely damaged. The survey hopes to reestablish a reference collection as geologic projects are completed, and new paleontological materials are acquired and thoroughly analyzed.

J. THOMAS DEWINDT and J. E. EDSON, JR., Shell Oil Company. Occurrence of Phytoplankton in Bloomsburg and Associated Redbeds, Central Appalachian Region. Twelve samples representing "redbed" clastics of the ?Middle and Upper Silurian Bloomsburg Formation of Pa., and its genetic counterparts in N.J. and N.Y., are being analyzed for presence of phytoplanktonic remains (acritarchs and sporomorphs). Microscopic study of the residues is still in progress, the results appear to document previously published paleoenvironmental conclusions by Hoskins (1961) and DeWindt (1972): samples from the northeastern portion of the Bloomsburg depositional basin were barren, thus constituting negative evidence of nonmarine paleoenvironments; samples from central Pa. yielded sparse phytoplankton (including, from the western part of the Landisburg Tongue, a sporomorph resembling the younger genus *Tasmanites*) which was probably deposited in marginal marine environments. Surprisingly, a sample from a highly carbonaceous stratum reported by Willard (1938) proved barren.

STEVEN F. DODIN, University of Pittsburgh. Molluscan Reversal and Mulluscan Faunal Size Variation in Pa., Ohio and W.Va. The concept of "molluscan reversal" states that, in general, the abundance and diversity of molluscan faunas decrease offshore, as contrasted with the increase in other faunal elements from onshore to offshore marine. Trends in relative adult sizes of molluscan faunas will also be examined. Theoretically, onshore infaunal molluscs will grow to a larger size than will onshore epifaunal species; offshore epifaunal species will grow larger than offshore infaunal species. Field data is being collected to test these hypotheses, from the Ames and other marine Conemaugh units.

PETER W. GOODWIN, RAVINDRA TIPNIS and FRANCIS T. MANNS, Temple University. Conodont Biostratigraphy and Paleoenvironments of the Beekmantown Group in Central and Eastern Pa. (1) Description on conodonts from Stonehenge and Axemann Formations for purposes of comparing Appalachian succession with conodont successions in western North America. (2) Interpretation of Beekmantown paleoenvironments, integration with biostratigraphy to produce a more complete paleogeographic picture.

C. WARREN NORTON, University of Pittsburgh. Paleoecology of Foraminifera in the Brush Creek Marine Event in the Appalachian Basin. Trench samples of Brush Creek shales and limestones are being quantitatively counted for their microfauna, particularly Foraminiferida. From this, with supporting data on sedimentary petrology and microfaunal analysis, paleoecological inferences will be made.

WILLIAM A. OLIVER, JR., U.S. Geological Survey. Rugose Corals of the Keyser Limestone in South-Central Pa., Md., Va., and W.Va.

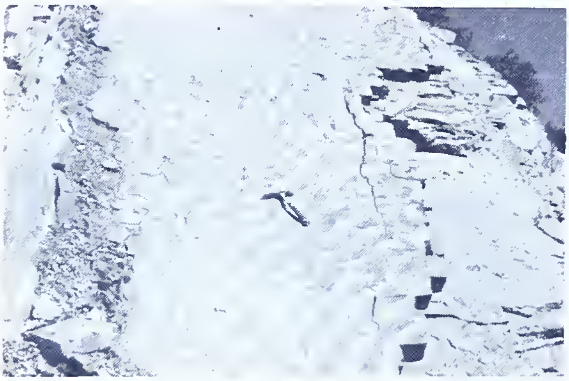
BARRY PERLMUTTER, Jersey City State College. Conodonts from the Keyser Group (Silurian) and the Helderberg Group (Devonian) in Pa. Samples will be collected and processed to recover conodonts using standard methods and equipment. The conodonts will be described and illustrated. The individual conodont elements will be grouped to form the whole organism empirically based on models previously developed. Correlation will be made with sections in N.Y., N.J., Md., Va., and W.Va. An attempt will be made to relate these conodont groupings to the environments represented in the Keyser and Helderberg Groups.

HORACE G. RICHARDS, The Academy of Natural Sciences, Philadelphia. Curating of Paleontological Collection — Including Specimens from Pennsylvania -- Preparatory to Moving to a New Building Planned for Late 1973.

HAROLD B. ROLLINS and JACK DONAHUE, University of Pittsburgh. Paleoecology of Conemaugh Marine Units. Study of the Upper Pennsylvanian marine benthic communities of the Appalachian Basin. This research is being conducted under the auspices of a National Science Foundation grant (GA 31898).

GRAIG D. SHAAK, Florida State Museum, University of Fla. Diversity and Community Structure of the Brush Creek Marine Interval (Conemaugh Group, Upper Pennsylvanian) in the Appalachian Basin of Western Pa. Transgressive-stillstand-regressive phases and their resulting organic communities have been recognized and identified in the Brush Creek marine interval. These results were obtained through application of diversity and equitability gradients to taxonomic frequency data in conjunction with more conventional paleoecological measures.

ALFRED TRAVERSE, J. B. WARG and BOBBY WILSON, The Pa. State University. Palynology of Upper Devonian-Mississippian Rocks, Centre County, Pa. We are working on the palynofloras of "Catskill-Pocono" rocks as exposed in Centre County, Pa., with special reference to the internationally important project (sponsored by CIMP — International Committee on the Microflora of the Paleozoic) of determining the Devonian-Mississippian contact on the basis of spores. A Belgian palynologist is cooperating by investigating spores from presumably equivalent levels in the Horseshoe Curve section near Altoona.



SEDIMENTOLOGY

J. D. GLAESER, University of N. Carolina, Chapel Hill. Deltas as Models for Subsurface Exploration — the Catskill Delta of the Central Appalachian delta deposits requires recognition and delineation of the delta front sandstones. The evolution of the delta front (Glaeser, 1973. Geol. Soc. America Abs. with Programs, v. 5, n. 2, p. 165) is controlled by subaqueous slope, width of the adjacent subaerial delta plain and locations of feeder streams. Westward, as slope lessened, the delta front developed more complex lobes and varieties of marginal marine environments. This increasingly complex coastal margin favors reservoir development for hydrocarbon stroage.

J. DOUGLAS GLAESER, Univ. of N. Carolina, Chapel Hill. Sediment Sequences in Catskill and Carboniferous Deposits: Analysis of Tectonic and Environmental Controls in the Appalachian Region. This is a study of vertical sequences and memory systems in two contrasting detrital clastic deposits. Use of facies "trees" shows the sequential (cyclical) nature of these deposits resulting from shifts in coexisting environments. Breaks in facies sequences not predictable from "tree" diagrams can be related to causes beyond the influence of the local depositional environment.

MARVIN E. KAUFFMAN, Franklin and Marshall College. Cambro-Ordovician Carbonates in Southeastern Pa.

JOHN B. ROEN, U.S. Geological Survey. Geology of the Sandstone Above the Pittsburgh Coal Bed, Northern Appalachian Basin, Pa., Ohio, W.Va. A study of the geometry, stratigraphy, petrology, and paleocurrents of the sandstone in the lower member of the Pittsburgh Formation.

STRATIGRAPHY

MARSHALL CAROTHERS, University of Pittsburgh. Depositional Environments of the Pine Creek Limestone in Western Pa., Ohio and W. Va.-Md. A study of the depositional environment of a Conemaugh (upper Pennsylvanian) marine transgression is presently being undertaken in the Pine Creek limestone. Investigations of the fossil community structure and comparisons with indicated delta facies and offshore marine facies are being undertaken. A regional history of this marine interval will aid in understanding the sequence of strata and fauna within the coal measures.

W. E. EDMUNDS and A. D. GLOVER, Pa. Geological Survey. Project TASIC. This project (Temporarily Available Stratigraphic Information Collection) is a continuing program involved with the recovery of stratigraphic data from active coal and clay strip mines and construction sites, while exposures are available. The long-term project is designed to provide data for future mapping and regional mineral resource evaluation. This information will also be useful in establishing the stratigraphic framework of coal-bearing rocks in western Pa., in making reserve calculations, in coal and coal land evaluation, in ground-water aquifer potential, in excavation and foundation information and in clay, shale, and other resource exploration.

RODGER FAILL, DONALD M. HOSKINS and RICHARD WELLS, Pa. Geological Survey. Middle Devonian Stratigraphy, Central Pa. Revision of Middle Devonian stratigraphy in central Pa. based on recent mapping in the area.

LOUIS HEYMAN, Pa. Geological Survey. The Oriskany Sandstone and Related Rocks in the Subsurface of Pennsylvania: 1. Stratigraphy and Areal Distribution in Western and Northern Half of Pa. Maps at 1:250,000 drafting scale are being compiled which will show: (1) the areal extent of the basal Bois Blanc, Ridgeley and Helderberg (?) units at present comprised in the subsurface Oriskany; (2) the thickness of these units; and (3) units underlying and overlying ("worm and birdseye view maps") these units.

STEPHEN H. HOLLIS, Bryn Mawr College. Geologic Map and Interpretation of the Fredericksburg 7½-minute quadrangle. A thorough investigation of the petrology of the "exotic blocks" and their relation to the surrounding Martinsburg Shale will be conducted. The "exotic blocks" include limestones, sandstones and volcanic rocks with pillow structures.

JON D. INNERS, Pa. Department of Transportation. Stratigraphy and Paleontology of the Onesquethaw Stage in Pennsylvania and Adjacent States.

WAYNE D. MARTIN and DOUGLAS LORENZ, Miami University, Ohio. Lithofacies, Paleocurrents and Environments of Deposition of the Dunkard Group in Ohio, Pa. and W.Va. This is a lithofacies, lithofacies-trend, paleocurrent, and environmental analysis of the Dunkard Group of the Dunkard Basin. Over 135 rock sections have been measured and described and about 1500 cross-bedding attitude determinations have been made over the past 20 years by Wayne Martin and several graduate students at Miami University.

GEORGE W. PEDLOW III, University of South Carolina. Facies Relationships, Depositional Environments and Source Terranes of Some Carboniferous Rocks in the Anthracite Region of Pa. This study will define the environments of deposition of the intertonguing sequence of red beds, green to gray shales, sandstones and conglomerates, coal and minor limestone which comprise part of the Carboniferous sediments (Llewellyn, Pottsville and Mauch Chunk Formations) in the Anthracite Region; will infer source area composition and tectonics; and will integrate findings with the depositional models recently developed for other Carboniferous rocks in the Black Warrior, Pocahontas and Dunkard Basins of the Appalachian region.

RICHARD B. WELLS, Pa. Geologic Survey. Stratigraphy and Economic Potential of the Loyalhanna (?) Limestone. Reconnaissance and preliminary stratigraphic study of a Mississippian limestone and calcareous sandstone unit which occurs near Philipsburg, Salladasburg, Forksville, and Shickshinny. If criteria can be developed for the identification of this unit in key outcrop localities in this area, it will be useful in the simplification and refinement of the Mississippian stratigraphic nomenclature and correlations across the Commonwealth. This unit will also be sampled for possible use as a non-skid highway surfacing material.

STRUCTURAL GEOLOGY

INA B. ALTERMAN, Herbert H. Lehman College. Detailed Mapping in the Hamburg 7½-minute quadrangle and the Northern Half of Temple quadrangle. The present detailed mapping project extends, refines and builds upon an earlier project of detailed reconnaissance mapping of the eastern end of the Hamburg klippe from Schuylkill River eastward. Now that the general structural and stratigraphic character of this part of the klippe is known to some extent, it is hoped that solutions to some of the unresolved structural and stratigraphic problems will be forthcoming from detailed quadrangle mapping. An attempt will be made to link up the geologic maps of the Hamburg and Temple quadrangles directly to the west mapped by Paul Myers.

ERNST CLOOS and F. J. PETTIJOHN, Johns Hopkins University. Triassic Overlap at Thomasville, Pa. A drillhole into the Triassic encountered an unknown conglomerate and a sequence of cyclic sandstones and mudstones which are 800 feet thick instead of about 150 if there is a normal gently dipping overlap. Faulting or an erosional scarp must have been present. Investigation will continue.

RODGER FAILL, Pa. Geological Survey. Fossil Distortion in the Valley and Ridge Province. Project examines fossil distortion in samples of the Trimmers Rock Formation from selected sites across the Valley and Ridge province. Data will be used to determine the contribution of flow to the Alleghenian folding, and to ascertain if there is any systematic variation across the province.

JOHN L. FAUTH, SUNY College at Cortland. Tectonic Significance of the Carbaugh-Marsh Creek Fault, South Mountain, Pa.

PETER HART, U. S. Army Corps of Engineers, Baltimore. Anomalous Structures in the Plateau of Bradford, Tioga and Lycoming Counties. Areas of high angle faulting and associated steep dips, surrounded by flat-lying Plateau structures, have been extended farther than previously mapped (Woodrow, 1968; Cathcart, 1934; Ingham, 1951). These faults may be connected to faulting recently mapped in the Williamsport area south of the Allegheny "Structural Front."

MICHAEL A. ROBERTS, JR., University of S. Carolina. Seismic Interpretation in Light of Modified Literature in the Chestnut Ridge-Summit Field, Pa. The subsurface structure of Summit Dome is interpreted from seismic data. An alternative method for the development of synclineward-dipping thrust faults is offered.

MARY EMMA WAGNER, University of Pa. Structure of Baltimore Gneiss and Glenarm Series in Chester County, Pa. A study of the structures and fabric of the Baltimore Gneiss and Glenarm Series in Chester County in an attempt to unravel the sequence of nappe formation, folding, faulting and the rise of gneiss domes. This study will be aided by samples from wells drilled in and near the Cream Valley fault zone, loaned by Roy Weston Company. Aeromagnetic maps will also be used as an aid to interpretation.

ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

October 5-6, 1973

Structure and stratigraphy of Central Pennsylvania.

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Write for pre-registration forms to the:

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SURVEY ANNOUNCEMENTS

MONROE COUNTY GEOLOGIC MAP OPEN FILE

The Pennsylvania Geological Survey announces that it is placing on open file a bedrock geologic map of Monroe County which has been compiled by W. D. Sevon and T. M. Berg, staff geologists, and J. B. Epstein, U. S. Geological Survey.

The map shows the distribution of the rock formations and their subdivisions in this area. The map is accompanied by brief discriptions of the various rock units. The scale of the geologic map is 1:48,000.

Final publication of full-color maps and complete text for Monroe County will occur in the form of a series of quadrangle reports to be published in 1974 and 1975. To meet the immediate needs of residents, developers, and planners in Monroe County, the Monroe County bedrock geologic map is now being placed on open file and may be examined in the Survey office, Towne House Apartments, 660 Boas Street, Harrisburg.

THREE NEW MINERALS FOR PA.

Pennsylvania mineral collectors have recently made three additions to the ever-growing list of minerals found in the State. Two of the minerals were found on a single specimen, while the third was found associated with the burning anthracite deposits previously reported in *Pennsylvania Geology*. All three minerals were identified by X-ray diffraction analysis by the Pennsylvania Geological Survey.

Neither langite nor posnjakite appeared in the most recent list of Pennsylvania's minerals (Grant, 1973), although the presence of posnjakite in Montgomery County has been suspected for some time. Both minerals were found on a sample recently collected by Mr. Martin L. Anńe, a mineral collector from Wrightsville in York County. The sample was collected on a surface dump at the Ecton Mine, an abandoned copper and lead mine on property now owned by the Audobon Wildlife Sanctuary in Montgomery County. The two minerals are apparently intimately intermixed, occur as very small, dark blue, transparent crystals of high luster and were found in a vug on a sample of limonite-bearing quartz. Both minerals have the same chemical formula, $Cu_4SO_4(OH)_6 \bullet H_2O$, the difference being that langite crystallizes in the orthorhombic system whereas posnjakite is monoclinic.

Langite has been known to the mineralogic world for some time, having been first described in 1864(Palache et al, 1951). Posnjakite, on the other hand, is a relatively recently described mineral, being first described in 1967 by two independent teams of investigators, A. I. Komkov and E. I. Nefedov of the USSR and M. E. Mrose and T. E. Reichen of the U. S. Geological Survey (Fleischer, 1967).

Hexahydrite, $MgSO_4 \bullet 6H_2O$, is a material similar in composition to the more familiar epsomite (epsom salt), $MgSO_4 \bullet 7H_2O$. Hexahydrite was found recently associated with a burning anthracite deposit near Glen Lyon in Luzerne County by Mr. Wayne F. Downey, Jr., a Harrisburg mineral collector. Hexahydrite occurs at this location as curved white columns and fibers up to approximately 6 millimeters in length, closely associated with epsomite. The rarity of this mineral is apparently the result of the narrow range of temperatures for which it is stable, from 48° to 69°C (118° to 156°F). At lower temperatures, additional water forms epsom salt (epsomite), at higher temperatures most of the water is removed, yielding kieserite, $MgSO_4 \bullet H_2O$ (Palache et all, 1951).

John H. Barnes

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STALACTITIC LIMONITE

During the study of the Altoona barite-limonite occurrence (*Pa. Geology,* v.4, no. 3, p. 4), stalactitic limonite was noted in the Eldorado Stone Quarry, south of Altoona and east of Canan (Caanan).

The limonite occurs as a 3 to 6 inch wide band between bedding planes of the Upper Tonoloway limestone, near its contact with the overlying Keyser Formation. Stalactites extend from the top of the band downward and resemble dozens of pencils all stacked together parallel to each other and cemented at the base (see photo).

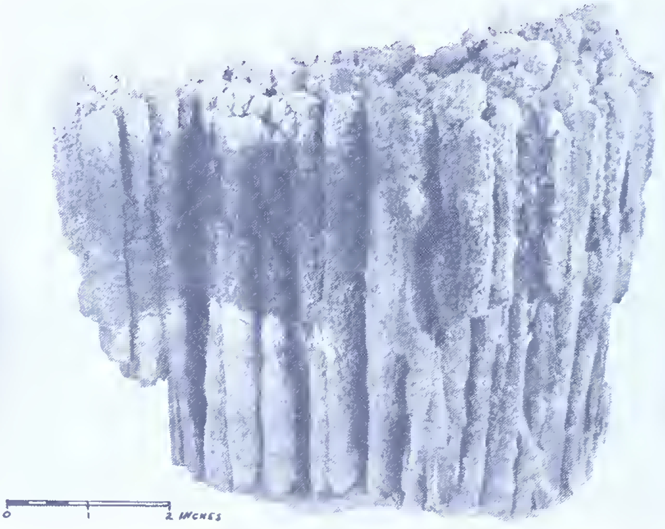
Some of the limonite, especially near the ends of the stalactite pencils, appears to be pseudomorphous after some former crystals, some of which probably were pyramidal marcasite; however, the slightly distorted crystal shapes have not been measured accurately to confirm the marcasite identification.

The stalactitic and crystalline nature of the limonite, and the presence of solution cavities and channels in the limestone directly above the limonite band suggest the following gensis. Calcium carbonate stalactites, perhaps rich in iron, grew by precipitation from groundwater flowing downward through solution channels as would occur normally in cave deposits. Marcasite, an iron sulfide, formed at surface temperatures on the stalactites as crystals and possibly as massive, crystalline material. Later, limonite, a secondary mineral formed under oxidizing conditions, possibly as the solution channels opened into caves, replaced the marcasite and carbonate, leaving little of the pre-existing minerals other than some crystal shapes that appear to be a "rhomb" of marcasite form. Similar-appearing marcasite crystals are known from other localities, but have not been identified previously on Pennsylvania stalactites.

The limonite bed is located near the crest of a large anticline exposed in the quarry involving the Keyser and Tonoloway limestones. (The axial plane of the fold is oriented N10 degrees East, plunges 22 degrees Southwest). Faulting both across and along bedding planes can be seen in the quarry face and slickensides and brecciation present additional evidence of offsets. Solution of the limestones was promoted by the fracturing and faulting and provided numerous opening and pathways for mineralization to follow.

The limestones from the Eldorado Quarry are used primarily for road metal, concrete and aggregate. Blasting has left many preciptious overhangs and steep rubble piles. Extreme caution should be exercised at all times while in the quarry. As always, permission to enter private land should be obtained at the quarry office prior to entering the quarry.

John H. Way, Jr.



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AUGUST 1973

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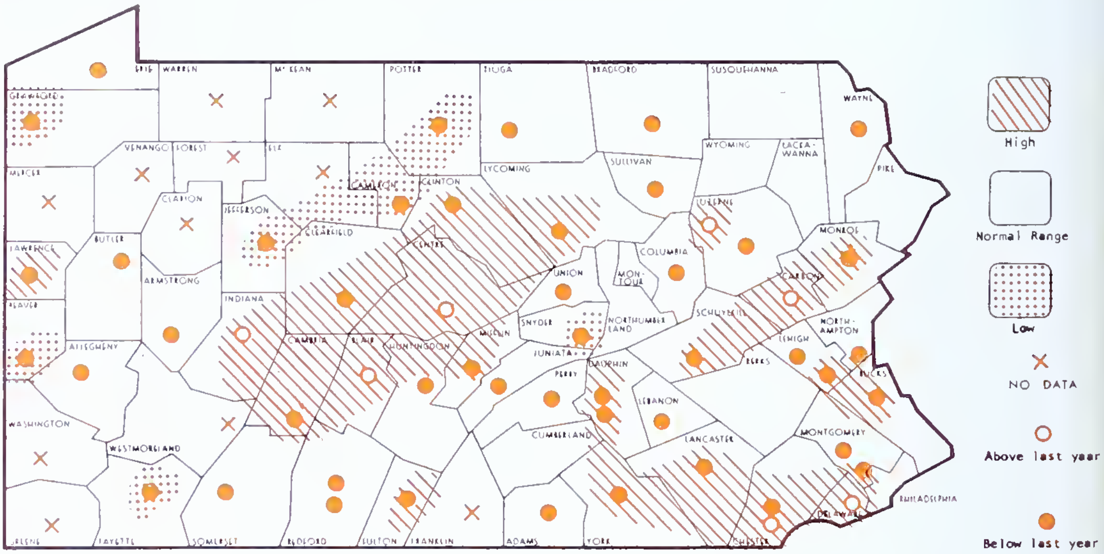

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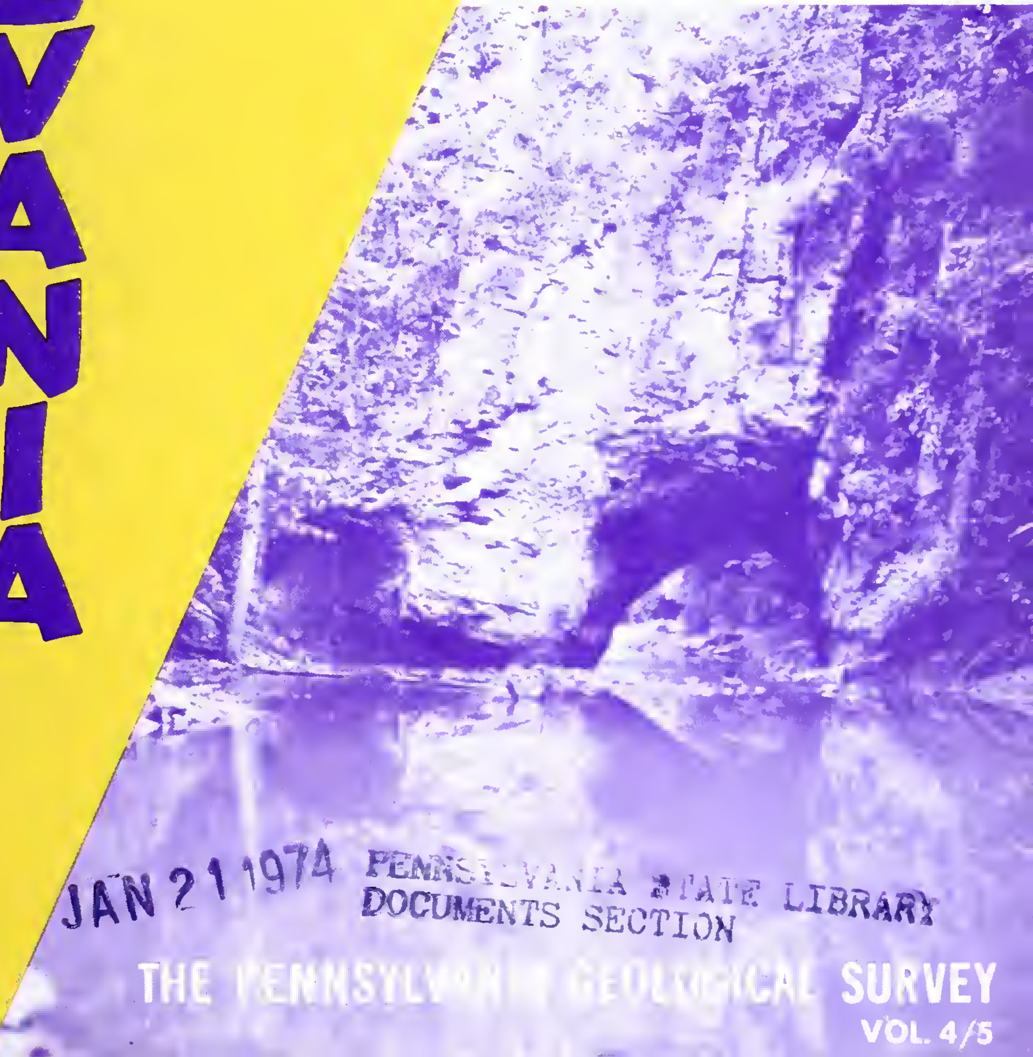

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DOCUMENTS SECTION

THE PENNSYLVANIA GEOLOGICAL SURVEY
VOL. 4/5

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER — View of Arch Spring, Blair County. With an average yield of about 8,000 gallons per minute, this is one of Pennsylvania's many outstanding springs.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

OCTOBER 1973

FROM THE DESK
OF THE
STATE GEOLOGIST

PENNSYLVANIA, WE'VE GOT YOU COVERED

We are pleased to announce that detailed topographic map coverage has now been completed for all of Pennsylvania. With the recent arrival of the Canton and Union City quadrangle maps, there are now available 764 published topographic quadrangle maps collectively covering every part of Pennsylvania's 45,025 square miles. Thus, Pennsylvania becomes the largest and only the twelfth state of the nation to have complete coverage by detailed topographic maps at a scale of one inch equals 2,000 feet.

Topographic maps provide an accurate, detailed representation of all natural and man-made features on the land surface, including elevations, slopes, roads, buildings, forests, rivers, and lakes, railroads, trails, public lands, and political boundaries. These topographic maps serve as a base for all land use activities, including basic planning, industrial and housing development, agricultural designing, road building, conservation and land rehabilitation projects, recreational facilities, river basin planning, and individual property utilization. Pennsylvania citizens surpass all other states in the utilization of our topographic maps, with an average of some 300,000 Pennsylvania topographic maps being acquired each year.

As the agency officially designated to prepare and maintain topographic maps for the Commonwealth of Pennsylvania, the Bureau of Topographic and Geologic Survey has been systematically engaged in topographic mapping for 54 years. In 1919 the Pennsylvania Survey entered into a cooperative agreement with the U.S. Geological Survey whereby the federal agency agreed to provide its technical expertise and manpower to prepare the topographic maps for Pennsylvania at highest quality standards. That cooperative agreement has been renewed each year since 1919, and represents an outstanding example of successful state-federal cooperation which has provided Pennsylvania with a premium product at a bargain price.

In the early days, topographic mapping went slowly as all work was done by parties of field surveyors who trudged over the mountains and through the forests to survey the entire landscape. By these methods, some 202 topographic maps on a less detailed scale of one inch to the mile were completed for Pennsylvania by 1946. It was soon recognized, that more accurate and more detailed maps were needed for the growing needs of Pennsylvania map users.

Thus, in 1946 there was initiated the monumental task of developing the new series of detailed quadrangle maps on a scale of one inch equal to 2000 feet. Called the 7½ minute series (because each map covers an area whose width is 7½minutes of longitude and height is 7½ minutes of latitude), these maps have been compiled with new, highly sophisticated techniques

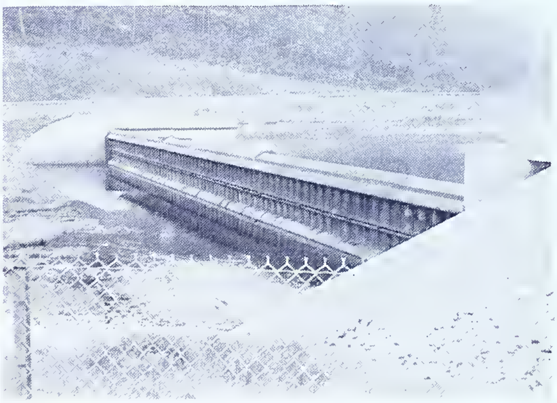
continued on page 12

GEOLOGY AND WILDLIFE MANAGEMENT

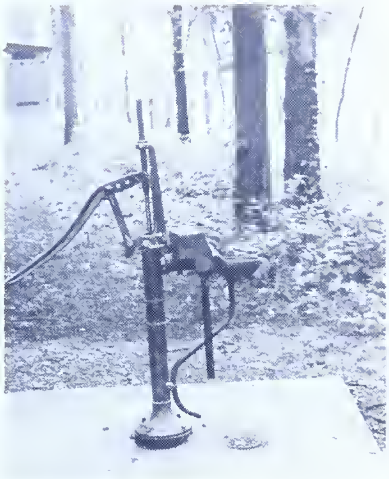
At first glance there appears little, if any, connection between the science of geology and the management of wildlife. However, in Pennsylvania these two subject areas and the two state agencies, the Bureau of Topographic and Geologic Survey and the Pennsylvania Game Commission, responsible for their administration have worked closely together through the years.

The most recent and perhaps the most dramatic example of this association has been the development of the Middle Creek Wiildlife Management area located on the Lebanon-Lancaster County boundary near Kleinfeltersville. Here more than 5,000 acres have been provided by the Pennsylvania Game Commission for waterfowl management. And since waterfowl need marshy habitat, a dam was constructed and a 400-acre shallow-water lake created.

In 1963 the Survey published a geologic map and report (Geology and Mineral Resources of the Womelsdorf Quadrangle) that was later used in all planning and development stages of the Middle Creek project. In the very earliest stage of the project, questions concerning the suitability of a dam site as well as the engineering characteristics of the rocks at the site were asked by the Game Commission and answered by the Survey.



Later, as planning and constructin of the dam and lake area progressed, the Game Commission designed four picnic areas that were to include tables, drinking water, restrooms and parking lots.



The Survey was asked to assist in selecting the best possible sites for drilling water wells for the picnic areas, to estimate the depth each well should be to secure the water needed, and to elaborate on other groundwater related characteristics of these sites. The geologic map and the Survey's groundwater inventory and research program provided the necessary answers.

Also included in the plans for this management area was a Visitor Center which would house wildlife and environmental displays.

As a final input to the Middle Creek Wildlife Management Area project, the Survey was asked to prepare simple sketches and short dialogue on the geologic history of the region. The exhibits contractor took this material and worked it into the first display case in a developing story ending with wildlife management in this southern Lebanon County region.

So you see, there is a connection between geology and wildlife management in Pennsylvania.

THE WOODBERRY ZINC-LEAD OCCURRENCE, BEDFORD COUNTY

Following the location once again of the Woodberry zinc-lead occurrence (latitude 40° 13' 12" and longitude 78° 26' 00", **Pennsylvania Geology**, April, 1973) in the Warrior Formation of northern Bedford County, a preliminary evaluation of the area was conducted by Survey geologists Bob C. Smith,II and John H. Way, Jr., using stream sediment geochemical prospecting. In addition, Tom Berg, another Survey geologist aided in air photo interpretation.

The geochemical prospecting technique used consists of collecting sediment samples, each a composite of ten sub-samples collected at ten-foot intervals, from the active stream channel. These composite samples, collected at approximately one kilometer intervals, were then analyzed for trace amounts of zinc and lead. This technique identifies areas with potential zinc and lead mineralization, helping to limit the area where more detailed study should be conducted. A total of 37 composite sediment samples were collected and analyzed (Figure 1). The median contents of zinc and lead were found to be 110 and 30 ppm, respectively.

While collecting stream sediment samples, the attitude and character of the available outcrop was noted. Because a fracture trace passes through the Woodberry occurrence, particular attention was paid to areas along the more pronounced fracture traces observable on aerial photographs.

During the sediment collecting stage, the following were observed:

1. Sphalerite grains in a black-rimmed, gray chert nodule in dolomite along an air photo fracture trace approximately 700 feet NW of the Woodberry gossan scar (Pb-Zn mine).
2. Minor galena with traces of sphalerite in fractured dolomite and one three-foot block of porous limonite with traces of smithsonite along the same fracture trace as the Woodberry gossan scar but approximately 800 feet NE of the scar. These samples had been moved to facilitate plowing, but their approximate original locations were indicated by the property owner, Ira M. Claar.
3. Purple fluorite and calcite in fractured limestone at several places which do not appear related to observed ore minerals, pronounced fracture traces, or the later-found geochemical anomalies.
4. Massive limonite float, including much shiny black goethite, collected 2000 feet SE of the intersection of Pa. routes 867 and 868. A composite sample consisting of 25 one-inch chips of the various types of limonite was found to contain only 40 ppm Pb and 230 ppm Zn, suggesting that this material contained little, if any, galena.

The zinc and lead trace element analyses shown on the accompanying drainage map (Figure 1) suggests that:

1. Further geochemical prospecting is warranted for the areas 1.25 miles

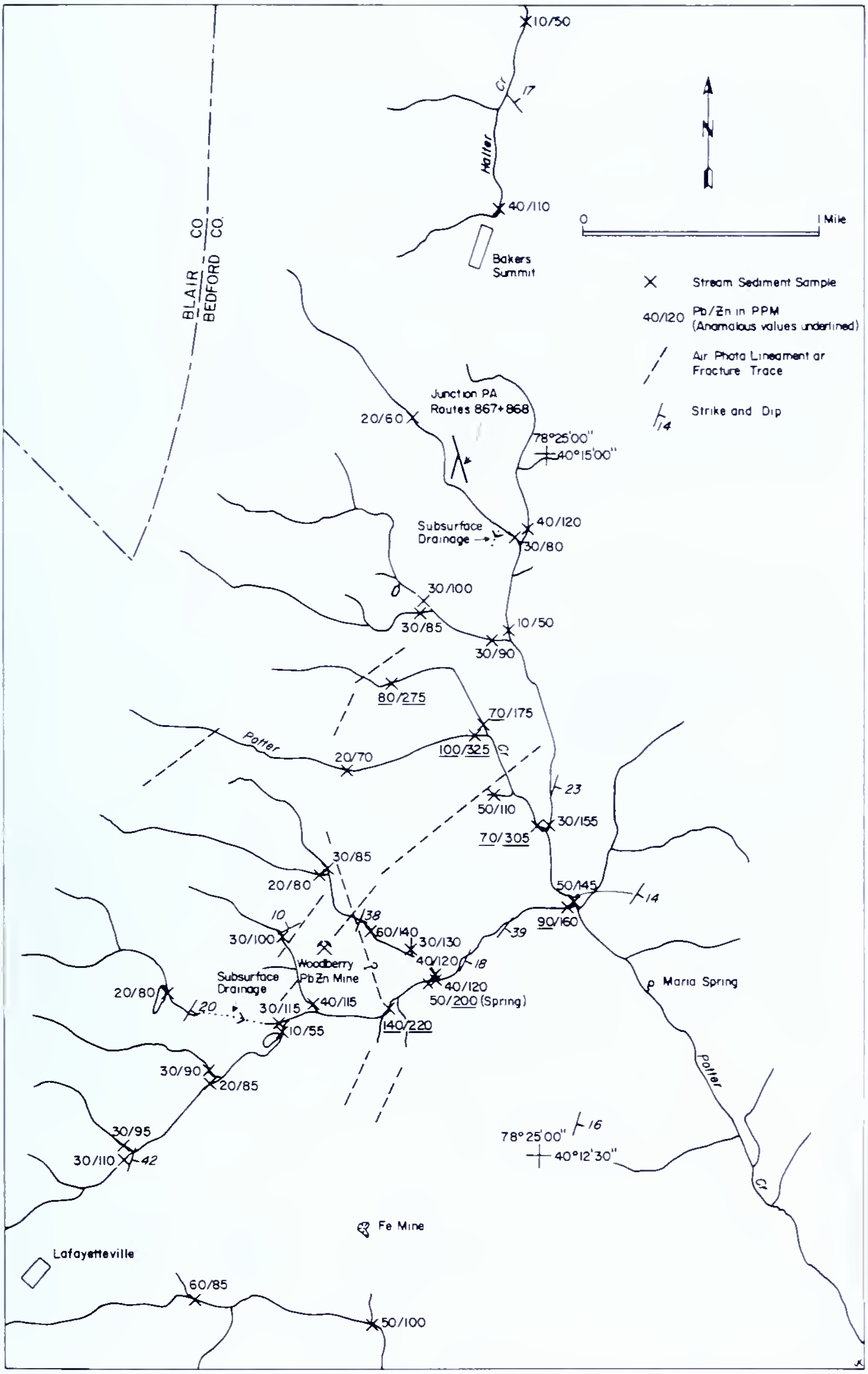


Figure 1. Zinc and lead content of stream sediments in the area of the Warrior Formation, host to the Woodberry occurrence, northern Bedford County.

NNE and 2000 feet SE of the Woodberry gossan scar (see map, Figure 1).

2. The observed geochemical anomalies are consistent with a nearly N-S discontinuous line of limonite ore deposits (referred to in the April article).
3. The Zn-Pb mineralization observed on the J.J. Snyder and I.M. Claar farms does not release sufficient metal to produce anomalous values in the streams. This could mean that the amount of mineralization is small or that some chemical or physical barrier (great depth, subsurface drainage, etc.) prevents metal from being transported into the present surface drainage. With the possibility of future economic recovery of zinc and lead to depths of greater than 2000 feet, lack of geochemical anomalies at the surface should not be a deterrant to exploration in areas with visible ore minerals, favorable dolomite country rock, and suitable structure.

The mineralization observed to date occurs in dolomite rather than limestone. The geology of the area indicates that mineralization may be occurring near the crest of a gentle NNE trending anticline located a few thousand feet above an ESE dipping thrust fault. It is suggested that the area of geochemical exploration be expanded to include the Mines and Gatesburg Formations and the Beekmantown Group. It is expected that a discussion of this, and other known Zn-Pb occurrences in central and southeastern Pennsylvania, will appear as a Survey publication within approximately two years. In the meantime, unpublished geochemical and geologic data obtained prior to May 15, 1973 will be considered "open file".

Bob C. Smith, II

LYTLE APPOINTED TO COMMITTEE

William S. Lytle, Chief of the Oil and Gas Division, has been reappointed to serve another three-year term as a member of the Petroleum and Gas Unit of the National Defense Executive Reserve (NDER) for the Department of the Interior. His position has been Director (Liaison) in the Production and Natural Gas Processing Division of Region II. The NDER provides an organization of trained men, who in the event of a civil defense emergency or an attack upon the United States, will report to the NDER unit and perform the functions for which they were trained, thus, assuring that the needs for national defense and the survival and the recovery of the Nation is accomplished.

Mr. Lytle has also been appointed to serve another year on the Technical Advisory Committee, U.S. Bureau of Mines Reservoir Evaluation Project.

ENVIRONMENTAL EFFECTS ON YOUR DEVELOPMENT DOLLAR

This was the title of a one-day seminar conducted by members of the Bureau in conjunction with the U.S. Soil Conservation Service and the Northwest Regional Planning and Development Commission.

The seminar, attended by 65 individuals representing Banks, Schools, Engineering firms, Builders, Realtors, and Landscape Architects, was opened by Dr. Arthur A. Socolow who spoke on the relationship of geological information to land-use planning and the involvement of the Bureau with applied problems of land development. He noted that regardless of the proposed land use, the nature of the rock formation, mineral resources, and water resources are vital to sound economical planning and development of that land.

Jesse L. Craft of the Bureau's Environmental Geology Division discussed the use of geologic information in urban planning.

Using illustrative examples, he showed where the use of geologic data would have prevented a major landslide; and in another case where geologic information was available but ignored and a disaster followed.

The afternoon was spent in a series of workshops covering different aspects of development planning: new erosion and siltation regulations and the clean streams law, the laboratory operation in a soils survey, methods and techniques used in developing a soils survey, the use of geologic maps in plan development and in the location of ground water resources, and how to apply soils information to development planning.

FREE PUBLICATIONS ARE AGAIN AVAILABLE

We are able again to provide copies of most of our most popular free publications. The devastating flood of June 1972 destroyed many tens of thousands of our maps and pamphlets distributed over the years free of charge. We now have new stocks and can supply them to interested people.

Available are the following:

Educational Series

ES 1 - Common Rocks and Minerals of Pennsylvania
ES 2 - Common Fossils of Pennsylvania
ES 3 - Ground Water in Pennsylvania
ES 4 - Pennsylvania Geology Summarized
ES 5 - Geology and the Gettysburg Campaign
ES 6 - Pennsylvania and the Ice Age
ES 7 - Coal in Pennsylvania
ES 8 - Geology of Pennsylvania's Oil and Gas

Maps

No. 7-9" x 12" Geologic map of Pennsylvania
No. 10-9" x 12" Oil and gas fields map of Pennsylvania
No. 11-9" x 12" Coal fields of Pennsylvania
No. 13-8-½" x 11" Physiographic provinces of Pennsylvania
No. 15 - Limestone and dolomite distribution in Pennsylvania
No. 27 - Industrial minerals produced in Pennsylvania

Information Circulars

IC 4 - Elevations in Pennsylvania
List of Publications (as of October 1972)

Park Guides

PG 1 - Ice mine and balanced rock; Trough Creek State Park
PG 2 - Hickory Run boulder field; Hickory Run State Park
PG 3 - Archbald pothole; Archbald Pothole State Park
PG 4 - Moraine State Park
PG 5 - Grand Canyon; Leonard Harrison State Park
PG 6 - French Creek State Park
PG 7 - Ohiopyle State Park

In addition, we have the 1971 Mineral Industry in Pennsylvania available as our bulletin IC 73.

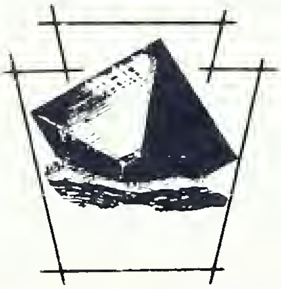
Single copies of any of these items will be sent to any individual requesting them. Bulk orders for classroom quantities of Educational Series, Maps or Information Circulars are limited to requests from teachers or public groups in Pennsylvania engaged in educational work.

ALLEGHENY COUNTY FIELD TRIP

Jesse L. Craft of the Environmental Geology Division recently conducted an environmental geology field trip of Allegheny County for the Pennsylvania Council for Geographic Education. The group visited a major landslide that involved a housing project as well as an outcrop of the Pittsburgh Coal with mine tunnels and roof collapse.

Rockfall and mine collapse at old coal working.

View of moving slope area threatening existing houses.



EARTH SCIENCE TEACHERS' CORNER

[illegible] usgs popular geology leaflet series

Several new U.S.G.S. leaflets have been released recently. The emphasis of their latest publications is, of course, on the environment.

"NATURE...AN ENVIRONMENTAL YARDSTICK", 16 pages.

"SELECTED BIBLIOGRAPHY ON MAPS AND MAPPING," 8 pages.

"MOTION PICTURE FILM SERVICES," 15 pages.

These pamphlets are available free of charge from the U.S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia, 22202.

[illegible] topo maps for teaching

The Pennsylvania Geological Survey has available a limited number of copies of topographic maps which have been superseded by newer, revised editions. These surplus quadrangle maps should be of value to teachers for classroom and laboratory exercises. We offer these at no charge on a first come, first serve basis. "Green" maps include a woodland overprint, "red" maps do not but show major highways in red. Contact Dr. Arthur Socolow, Pennsylvania Geological Survey, Harrisburg, Pa. 17120.

7½ Quadrangle	**Year**	**No. of Copies**
Allenwood	1965	16-Red, 39-Green
Ashville	1961	12-Red, 4-Green, 3-Plain
Barrville	1966	20-Red, 23-Green
Beavertown	1965	17-Red, 37-Green
Bellefonte	1962	18-Red, 32-Green
Belleville	1966	16-Red, 34-Green
Cammal	1965	16-Red, 37-Green
Carmichaels	1964	16-Red, 37-Green
Cogan Station	1965	19-Red, 27-Green
Conrad	1947	4-Green
Cornplanter Run	1966	18-Red, 38-Green

Crosby	1950	4-Green
Driftwood	1947	4-Green
Farrandsville	1966	22-Red, 33-Green
First Fork	1947	4-Red
Glen Union	1946	4-Green
Hammersley Fork	1946	5-Green
Hammett	1960	4-Green
Hartleton	1965	16-Red, 42-Green
Holbrook	1964	17-Red, 45-Green
Huntley	1959	4-Green
Iron Springs	1953	11-Red
Irvona	1959	4-Green
Jersey Shore	1965	16-Red, 40-Green
Karthaus	1959	4-Green
Keating	1946	4-Green
Keating Summit	1948	4-Green
Lee Fire Tower	1947	4-Red
Lewisburg	1965	16-Red, 41-Green
Lock Haven	1965	16-Red, 30-Green
Lucinda	1967	23-Red, 3-Green
Madisonburg	1966	16-Red, 3-Green
Mayburg	1966	16-Red, 47-Green
Mifflinburg	1965	16-Red, 38-Green
Milton	1965	16-Red, 36-Green
Nanty Glo	1965	12-Plain, 3-Green
New Freeport	1964	18-Red, 46-Green
Norwich	1948	4-Green
Oak Forest	1961	16-Red, 47-Green
Pottersdale	1959	4-Green
Prosperity	1964	15-Red, 43-Green
Rogersville	1964	16-Red, 44-Green
Russell	1954	4-Green
Scandia	1954	4-Green
Sheffield	1966	16-Red, 43-Green
Sinnemahoning	1945	4-Red
Snow Shoe NE	1960	4-Green
Stickney	1966	16-Red, 44-Green
Sunbury	1965	15-Red, 33-Green
Tamarack	1946	4-Red
Warren	1954	4-Green
Waynesburg	1961	16-Red, 45-Green
Westover	1959	4-Green
Wharton	1948	4-Green
Wildwood Fire Tower	1948	4-Green
Williamsport SE	1965	16-Red, 47-Green

SURVEY ANNOUNCEMENTS

SURVEY LIBRARY NEEDS

The Pennsylvania Geological Survey Library has need for the following items to help with its post-flood replacement efforts. We have received unbelievably generous help in our rebuilding program to date. If anyone has any of the following items to contribute, please contact State Geologist Arthur Socolow in Harrisburg.

Journal of Paleontology, need vol. 2 and 5 through 7
Journal of Petrology, need vol. 1 through 12
Journal of Sedimentary Petrology, need vol. 1 through 25
Sedimentary Geology, need vol. 1 through 6
Tectonophysics, need vol. 1 through 4
Canadian Journal of Earth Sciences, need vol. 1 and 2
U.S.G.S. Memoirs 15 and 18

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continued from page 1

including aerial photography and automated terrain plotting instruments.

In completing statewide coverage by topographic maps, the Bureau of Topographic and Geologic Survey extends appreciation to its technical program partner, the Topographic Division of the U.S. Geological Survey and to the Pennsylvania Department of Transportation which in recent years provided some financial support to expedite the mapping program.

Even as the map coverage was being completed, work was already begun to revise and update the topographic maps in those areas where new man-made features, such as roads, buildings, lakes, and industry have changed the landscape. This revision program will proceed so that the vast array of topographic map users can be assured of reliable maps upon which to plan and utilize Pennsylvania's landscape.

Topographic maps may be purchased from a lengthy list of retail outlets throughout the state, or from the U.S. Geological Survey. A detailed listing and index map with ordering instructions is available upon request from the Pennsylvania Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, Pennsylvania 17120.

Arthur A. Socolow

UPPER DEVONIAN OPEN FILE REPORT

A short report by J. Douglas Glaeser presenting detailed measured sections and interpretation of depositional environments of newly exposed Upper Devonian rocks on Interstate 80 between Milesburg and Snow Shoe and on the west bound lane of Route 322 at Port Matilda has been placed in the Pennsylvania Geological Survey Open File. The newly measured sections are presented as columnar sections and by field description. An index map shows the location of these sections and a generalized stratigraphic correlation diagram of these sections with the classic section at Horseshoe Curve west of Altoona is included. This report is available for *inspection only* in the Harrisburg office of the Pennsylvania Geological Survey.

TWO POPULAR BOOKS REPRINTED

Bulletin G 40, Fossil Collecting in Pennsylvania, and Bulletin IC 54, Directory of the Mineral Industry in Pennsylvania, are again available for sale. "Fossil Collecting" contains 63 localities for collecting fossils throughout the Commonwealth and has been reprinted with a new cover design. Sketches of fossils to be collected are also included.

The "Directory" is an easily used source for discovery of who produces and where mineral commodities are produced in Pennsylvania. Over 50 mineral commodities are listed and arranged by commodity and county.

Bulletin G 40 sells for $.50 plus $.03 tax and Bulletin IC 54 for $1.80 plus $.11 tax. Prepayment is required and the books are obtained by writing to: Department of Property and Supplies, Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125.

THE OLDEST ROCKS AND THE AGE OF THE EARTH

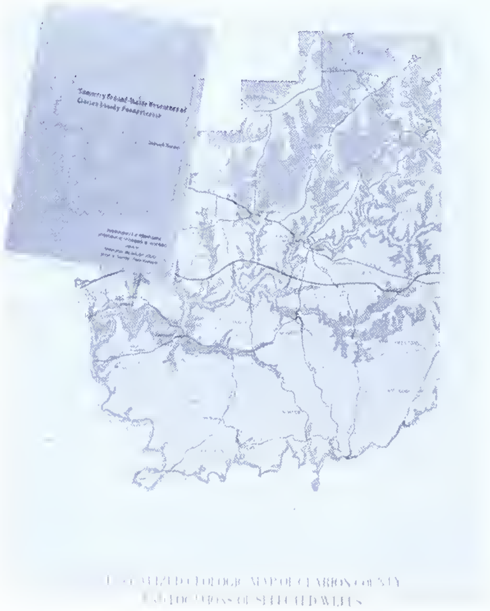
The oldest rocks found on Earth, up to the present time, are from western Greenland. They have been dated radiometrically in two ways, by using rubidium and strontium isotopes and by using lead isotopes from common lead and from uranium decay. The first method yields a rock age of about 3980 million years and the second an age of about 3620 million years. On the basis of calculations which relate the age of the Earth to rock measurements, the age of the Earth had previously been though to be 4550 million years, but an analysis of the new data by A.K. Sinha (Carnegie Institute of Washington) and G.R. Tilton (University of California) indicates that its age may be slightly more, about 4660 million years old.

The oldest North American rocks dated by radioactive methods are almost 3400 million years old. The oldest rocks dated up the present time in Pennsylvania are much younger, a mere 1100 million years. In Pennsylvania, rocks of this age occur in the extreme southeastern part of the state and also have been dated from subsurface core samples near Erie, in the extreme northwestern corner of the state.

CLARION COUNTY GROUNDWATER REPORT

All users of water resources in Clarion County can benefit from the new report, "Summary of Groundwater Resources of Clarion County, Pennsylvania" which has just been published by the Bureau of Topographic and Geologic Survey.

With the continuing growth of our population and the expansion of our industries, there is an ever increasing demand for quality water resources. Ground water constitutes one of the largest reserves of quality water remaining to be developed. This new report on Clarion County ground water presents a comprehensive description and inventory of groundwater resources available in the county. It will help to evaluate the quantity and quality of ground water available in any part of the county, and it will aid in choosing the locations, depths, and conditions most favorable for the desired water yield. Planners, architects, contractors, and all citizens may benefit by the help that this new report can give in developing and managing the water resources of Clarion County.


GENERALIZED GEOLOGIC MAP OF CLARION COUNTY
LOCATIONS OF SELECTED WELLS

Prepared as part of a cooperative project between the Pennsylvania Geological Survey and the U.S. Geological Survey, the text of the new report was authored by Thomas G. Newport. Containing 42 pages, six figures, and a county geologic map at a scale of 1:125,000, Water Resources Report 32 is available for $2.15 (plus 13 cents sales tax for Pennsylvania residents) from the Pennsylvania Bureau of Publications, P.O. Box 1365, Harrisburg, Pennsylvania 17120.

CACTI IN PIKE COUNTY

In an attempt to examine all known occurrences of lead and zinc in Pennsylvania, references to those metals in the publications of the Second Pennsylvania Geological Survey, 1874-1887, are being field checked. One such reference, I. C. White (1882), briefly describes the occurrence of lead, zinc, and copper in the Hamilton Group sandstones which form a 600-foot high cliff between Matamoras and Milford, Pike County, Pennsylvania. White also stated that the cliff is covered with prickly pear cactus plants of the "species *Opuntia vulgaris,* the discovery of which is due to Dr. Barrett, of Port Jervis."

Unfortunately, no traces of lead, zinc, or copper were found when visited by the writer in early August, 1972. It seems likely that White may have mistaken the irridescent, hydrocarbon-like films, common on fractures in Hamilton Group rocks here and elsewhere in Pennsylvania, for base metals. As only a small percentage of the cliff is accessible, it is still possible, however, that White was correct.

White's report of cacti, on the other hand, is definitely correct, but at the present time, there are as many rattlesnakes as cacti. The accompanying photograph shows one of these cacti growing in a slide initiated by tropical storm Agnes. This plant has been identified as *Opuntia compressa* (Salisb.) Macbr. (*O. vulgaris)* by Arthur O. Tucker, III, a botany graduate student at Rutgers University. Two articles brought to our attention by Mr. Tucker in the **Bulletin of the Torrey Botanical Club** (vol. 96, nos. 5 and 6, pages 592 to 594 and 641-652, respectively) describe studies of *O. compressa* in New Jersey by Sharon Hanks and David Fairbrothers. Hanks and Fairbrothers found that for New Jersey there was no correlation between the presence of this cacti and slope (0-50%), soil composition (Ca, Na, Mg, and K), soil pH (3.1-7.5), organic matter, or other plant species. Thus, although Matamoras is the only prickly pear occurrence in Pennsylvania known to the author, this plant is not supposed to be very particular where it makes its home. According to H. A. Gleason and A. Cronquist (Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 1963) this variety of prickly pear makes its home on rocks, sand dunes, or sandy prairies from eastern Massachusetts to southern Ontario and southern Minnesota and south to Georgia, Alabama, and Missouri. It is not found in the far west!

Bob C. Smith, II

MEET THE STAFF

Peter Wilshusen

Peter Wilshusen joined the staff of the Pennsylvania Geological Survey in 1963 as a geologist in the Field Division. He started work on a geologic mapping project in the Appalachian Mountain section of the Valley and Ridge province. In 1965 he left the Survey and worked as an Engineering Geologist for Gannett Fleming Corddry and Carpenter, Inc. until 1969. At that time, he was Resident Engineer on the construction of the Yellow Creek Dam in Indiana, Pennsylvania. Pete returned to the Survey's new Environmental Geology Division in 1968 and was subsequently appointed to the position of Geologic Editor in 1970. In the Environmental Division, he co-authored the Survey's first environmental geology publication on the Engineering Characteristics of the Rocks of Pennsylvania.

The Survey's staff has grown, through several periods of expansion, to meet the increasing demands for geologic information resulting from needs of the scientific, industrial and governmental communities. Much of this information is presented through formal geologic reports and the Editing Section has grown with the rest of the Survey to meet the new demands. Pete works with an Assistant Editor, a Secretary, and four Cartographic Draftsmen in a continous effort to keep up with publication deadlines.

Peter was born in Port Chester, New York in 1930, received a B.S. in Geology from the New Mexico Institute of Mining and Technology and an M.S. in Geology from the South Dakota School of Mines and Technology. As an avocational interest in New Mexico, he held a manganese claim with four other students, spending some weekends and vacations taking psilomelane from a vein in rhyolite in the foothills of the Magdelana Mountains. In South Dakota, he worked one summer for the state sampling streams in relatively remote sections of the Black Hills, gathering data for a geochemical study.

After two years in the U.S. Army Signal Corps, in 1957, Pete married Jane Purinton, a public health nurse. The Wilshusens now have four children ranging in age from 6 to 15 years.

Pete is a member of the American Association of Petroleum Geologists, the Association of Engineering Geologists and the Association of Earth Science Editors.

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In Cooperation with The

SEPTEMBER 1973

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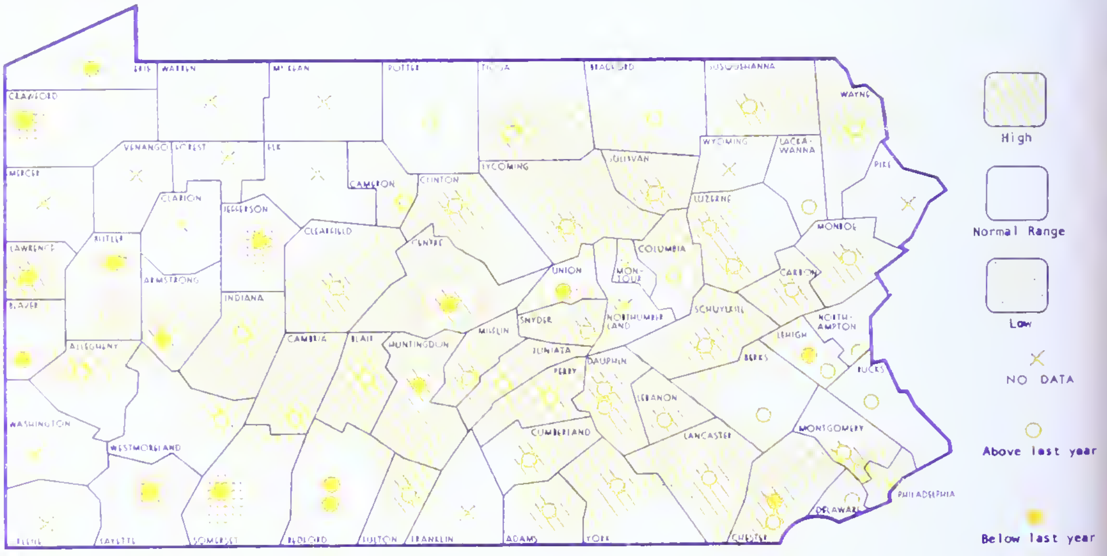

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Arthur A. Socolow, State Geologist

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PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

DECEMBER 1973

FROM THE DESK
OF THE
STATE GEOLOGIST...

THE CRISIS THAT CAME TO STAY

The enormity and gravity of the problem prompt me to turn again to the fuel and energy crisis. Amidst the mass of data and analyses issued on the subject, a number of points merit emphasis:

1. The energy and fuel shortages did not develop overnight; our accelerating rate of consumption had surpassed our domestic fuel production for several years.
2. Our fuel shortages cannot be resolved overnight; there is a certain amount of lead time (one to four years) necessary even for the most readily available relief measures.
3. Reduced energy consumption is a necessity for immediate relief; it is not a permanent solution for the aspirations of our American society nor for the underdeveloped nations of the world.
4. No single procedure will resolve our energy needs; it will take the combined effects of increased production of coal, oil and gas (including offshore development), more nuclear energy, production of oil and gas from coal, oil shale, and tar sands, and greater utilization of geothermal energy.
5. Some other touted methods are 20 to 40 years away from technical reality and widespread usage; this probably includes solar energy and fusion.
6. Under the stress of the crisis, we must not allow ourselves to accept the premise that we have to choose between more energy or environmental quality. With reasonable objectives and standards, we can and should have both.

Pennsylvania can make major contributions to easing the energy crisis. Large reserves of minable coal (both bituminous and anthracite) are available for direct use and for new gasification and liquifaction techniques. Our existing oil and gas production could be expanded by exploration of large, favorable, untested deep zones. And we have a valuable pool of academic and industrial researchers capable of leading us to new, applied energy techniques.

The Topographic and Geologic Survey is pushing ahead with a program of defining our coal, oil and gas resources in greater detail. We are pleased that industry and government have already been able to put our data and services to good use in dealing with the crisis.

Arthur A. Socolow

THE FUTURE OF ANTHRACITE,— A POSSIBLE SOLUTION TO THE SULFUR PROBLEM

During the past few years, the coal industry has been aware that its importance to our economy will increase at the end of this century, at least until nuclear fuel can account for a significant portion of the energy market. The gasoline shortage in the spring of 1973, the oil shortage for the winter of 1973-1974, and the very real possibility of more shortages of railroad cars available for coal transportation all have added to a vigorous search for energy sources, and especially for coal which is known to have large domestic reserves. Some of this recent attention has been focused on Pennsylvania, both because of our large coal deposits and because of our proximity to the large eastern market area. Rumor and speculation have been particularly rife concerning the Pennsylvania anthracite district, an area of declining coal production. The question is, will the new need for coal energy revitalize the Pennsylvania anthracite area in spite of the technological and economic problems involved?

One factor in this speculation has been the sulfur content of coal which eventually produces the environmentally deleterious SO_2 as a contaminant in the air. Either a low-sulfur source or a method of economically removing sulfur from stack gas, or both, has been sought. In 1970, the Clean Air Act stipulated that 1.2 lbs. of SO_2 per million BTU input was the maximum permissable amount (equivalent to about 0.6 lbs. of sulfur per million BTU). Future national regulations, or more strict state laws, may further lower the amount of permissable SO_2. In fact, present planners are using a figure of 90% sulfur removal, a figure that includes a safety factor of 5-15% sulfur and which they hope will suffice for any stricter regulations that may accrue. The rumors regarding a possible upsurge in anthracite mining thus are based on the general knowledge that anthracite is a relatively low-sulfur coal with a rather high BTU value and consequently it may meet the new environmental standards with little or no stack scrubbing, a process which may increase coal costs by 20-25% in the case of lime used as a sulfur-removal material.

Although the BTU range of Pennsylvania anthracite is large and may vary both laterally and vertically, the BTU content after simple cleaning and drying operations can approach 12,500 BTU, a rather high-energy coal source. Furthermore, large coal reserves are known to exist here, particularly in Schuylkill County in the Southern anthracite field (Edmunds, 1972). Although its BTU content is not quite as high as Pennsylvania bituminous coal which may approach 14,500 BTU after cleaning and drying, anthracite is higher in BTU content than coal from the Western United States and it is close to the large eastern market.

The sulfur content of coal is likewise variable and averages cannot be expected to directly reflect the sulfur content of any one coal or one local mine. They do, however, give an indication of whether or not sulfur must be removed, and approximately how much, to meet current minimum standards. A preliminary compilation of such average sulfur contents by the Pennsylvania Geological Survey is given in the accompanying table, based upon about 600 anthracite analyses. The sulfur content listed for bituminous coals is an estimate. Two observations are immediately apparent: 1) anthracite coal in Pennsylvania contains only one third as much sulfur as Pennsylvania bituminous, and 2) the coal of the Middle and Southern anthracite fields contains much less sulfur than the coal from the Northern anthracite field. The question then arises as to whether Southern or Middle field anthracite would meet present air-pollution standards without special SO_2 removal techniques.

Table of Approximate Average Sulfur In Pennsylvania Coal

Area	Avg. % sulfur	Range % sulfur
Northern anthracite field	0.87	0.5 - 3.5
Middle anthracite field	0.60	0.3 - 1.7
Southern anthracite field	0.68	0.3 - 1.7
Pa. anthracite seams	0.76	0.3 - 3.5
Pa. anthracite culm	0.80	0.4 - 2.7
Pa. bituminous coal	1.8 - 3.0	0.3 - 7.0

Utilizing the 1970 permissable sulfur limits, the minimal BTU of coals containing different sulfur contents can be calculated. For example, a coal containing 3% sulfur would require a coal with more than a 50,000 BTU content, a 1% sulfur coal about 16,000 BTU, a 0.8% coal about 13,300 BTU, and a 0.7% sulfur coal about 11,600 BTU. From the known BTU content of Pennsylvania anthracite and bituminous coal, it becomes obvious that all bituminous and most Northern field anthracite would require additional sulfur removal. For anthracite from the Northern field, approximately 20-30% of the sulfur would have to be removed to meet current federal standards; more for coal at some localities. For Pennsylvania bituminous coal, 70% or more of the sulfur would have to be removed.

It is most noteworthy that the sulfur situation for Southern and Middle field anthracite, however, is strikingly different. For these coals, the average per cent of sulfur yields BTU contents that are attainable and thus these coals might be used without special scrubbing and still meet minimal pollution requirements. Anthracite (cleaned and dried) with about 0.7% sulfur or less is both acceptable and available.

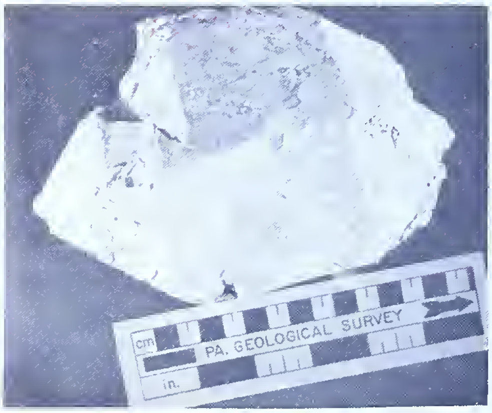
Other questions may arise. For example, the sulfur contents quoted are averages and hence either low to moderate sulfur anthracite would have to be selectively mined or integrated mining and mixing of coal is required throughout a district. This in turn would require a considerable initial investment. In addition, mining costs in this district would be higher because the coals have a steep dip and are complexly folded and faulted.

Dewatering and keeping water out of areas being mined would have to be considered. However, the prospect of either no sulfur removal or a single rather than a dual process sulfur-removal system is a significant advantage in the consideration of Pennsylvania anthracite for economically permissable mining. The rather low transportation costs to bring it to market and the fact that this is an area of good labor supply also are in its favor.

We believe that an expansion of mining in the Pennsylvania anthracite district, primarily because of its low sulfur content, deserves consideration. Energy sources are in increasingly short supply and an increased cost for fuel, whether coal, oil, gas, or electricity, can be expected over the next 25 years. It is now that plans should be made for the potential use of Pennsylvania's anthracite.

by Davis M. Lapham

CONSIDERABLE CUMBERLAND COUNTY CRYSTAL



An eight-inch long, eight and one half pound quartz crystal was recently collected by Dr. Samuel Root during geologic mapping in Cumberland County. It is composed of milky quartz and is doubly terminated with equal development of positive and negative rhombohedral faces. This unusually large crystal was discovered in a stone pile in a farmers field about 9000 feet WSW of New Kingston. Underlying these fields are limestones and dolomites of the upper part of the Ordovician Beekmantown Group. Although chert and quartz rosettes occur at this horizon (See Pennsylvania Geologist vol. 1, no. 8) quartz crustals of this size are unknown.

Reasons for development of such a large crystal have not been ascertained, however, two ideas should be considered. First, a large west dipping thrust fault passes within several hundred feet of the collection site so that the crystal development could be related to silica-rich fluids migrating along the fault. Second, possibly it may be related to Triassic dike intrusion into chert and quartz bearing carbonate rocks, as Stony Ridge dike is only several hundred feet from the collection site. Mineral collectors should be especially vigilant where similar geologic relations are duplicated elsewhere.

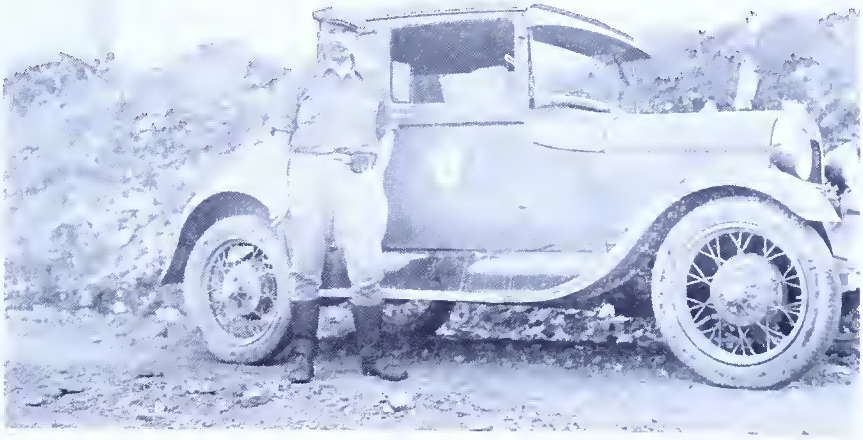
PENNSYLVANIA LOSES A NATIONALLY-KNOWN SCIENTIST

Dr. Bradford Willard, past member of the Bureau of Topographic and Geologic Survey and past Chairman of Lehigh University's geology department, was a creative geologist throughout every phase of a career that spanned 52 years. For those who knew Dr. Willard, or "Brad" as his friends called him, his probing mind, and his dry wit will always be remembered.

The Survey came to know Dr. Willard best after he reported to work that Monday morning July 1 in 1929, and remained on the staff for the next nine years. He came to us after several previous years as instructor at Brown University and Harvard. Prior to that time, he had graduated from Lehigh University and received his Ph. D. degree from Harvard.

Dr. Willard was one of the most prolific writers to have been associated with the Pennsylvania Geologic Survey having written some 96 books, articles, and pamphlets on some aspect of Pennsylvania geology. During his years with the Survey his major pursuits were in the fields of stratigraphy and paleontology. His best-known work was the Survey's Bulletin G-19, "The Devonian of Pennsylvania". This book is a true classic. Written in the late '30's this is required reading even today for all new staff members and in most geology departments around the State.

Probably the most widely circulated of Dr. Willard's publications is the Survey's Educational Series Bulletin ES-4, "Pennsylvania Geology Sum-



Dr. Bradford Willard, Survey field Geologist in the 1930's marized". Originially published in 1935, it has since gone through several revisions, the last of which was in 1962, and is currently in its sixth printing, with tens-of-thousands of copies having been distributed.

The Delaware Water Gap held a particular scientific fascination for Dr. Willard. Many of his publications were written on the rocks and fossils of this region. He soon came to be the foremost authority on the geology of that area.

At a Lehigh University faculty dinner in June 1959 honoring his 20 years as Geology Department Chairman, a silver tray was presented by his colleagues. At that same time, a Survey publication titled, "The Geology and Mineral Resources of Bucks County, Pennsylvania", by Dr. Willard and others, was just released and the first hard-bound book with maps were presented to him. Dr. Willard had labored for many years to see the Bucks County report come to be a reality. Here at last was one of the best county reports ever published by the Survey.

With his passing, the Pennsylvania Geologic Survey, the Commonwealth, and the field of geology lost one of its most brilliant, versatile, and enjoyable men. His work remains a testament to his ability. Although it is impossible to write an adequate summation of any man, he exemplified a unison of sparkling sociability and scientific objectivity. Whether as Dr. Bradford Willard, or simply as Brad, he was a man toward which all of us can set our aim.

Dr. Willard is survived by his wife, son and daughter. His son, Gates Willard, is also a prominent geologist.

NORTHEAST SECTION OF GSA TO MEET

The annual technical meetings of the Northeast Section of the Geological Society of America will be held at the Baltimore Hilton Hotel on March 21-23. The wide-ranging program will include special symposia on *Mining in Northeast Urban Conditions, Chesapeake Bay Environmental Conditions, and Structural Problems of the Coastal Plain.* For further details contact Dr. Arthur Socolow, GSA Section Secretary. Pennsylvania Geological Survey, Harrisburg, Pa. 17120.

Errata:

The Pennsylvania Geologic Survey recently completed a core drilling project in the Dubois area. As reported in the June 1973 issue of Pennsylvania Geology (vol. 43), the location of drill hole No. 2 is in error. The correct coordinates should read: 41 12' 57" N. latitude, and 78 55' 16" W. longitude.

WHAT STARTS A COAL MINE FIRE?

Coal mine fires have been a great concern to many people during the past century. Not only are they dangerous to living creatures, both human and wild life, they also can be quite costly as they consume the important fossil fuel which is in great demand today. The concern now is to put out these fires and hopefully to eliminate the threat of harmful pollution that accompanies them. A question that many people ask is what starts these fires, a question not only of curiosity but also born of the need for prevention. In some cases, it is a freak accident of nature, but mainly they began from some careless mistake of man.

One possibility for their ignition is spontaneous combustion. This may occur as air mixes with combustible fuel dust and methane gas such that the coal begins to oxidize. The insulating strata surrounding the coal beds will contain the heat given off by oxidation and may slowly raise the temperature to the point of ignition. Tests in laboratories have shown that this process can actually occur and by removing the source of air currents the heating slows down or even stops.

Nature also can play other roles in originating these fires by unintentionally igniting a coal bed or culm-bank pile. For example, forest fires and lightning undoubtedly start some fires that eventually ignite a nearby coal seam or such fires may come in direct contact with the coal. A thick accumulation of organic plant and animal debris also might provide sufficient heat through oxidation to ignite a fire. Consequently, organic debris should not be placed near coal deposits or culm banks.

By far the greatest contributor to the fires is the carelessness and ignorance of man. Ignition of coal may result from the burning of trash and garbage near an old coal mine. Because of the convenience of an abandoned nearby "dump hole," trash may be taken to a mine. The coal nearby then may ignite to create an uncontrollable fire. Campers who leave burning fires or hot ashes create an ideal situation for starting a culm or coal seam fire. Miners can also start the fires either intentionally as may have occurred at Shenandoah, Pennsylvania or by an unfortunate accident as at Glen Lyon, Pennsylvania. It has been reported that some fires are purposely started to produce "red dog" an ash used for pavement, landfill, and bricks (see accompanying table).

The background of four fire sites examined by the Survey has provided some interesting stories (also see table). One account of the Shenandoah fire places the blame upon bootleggers who dumped a burning stove down the shaft when their illegal operation was discovered. Another description of the same fire states that the fire began when some burning timbers from an enginehouse fell down the shaft. The Glen Lyon culm fire which started in 1932 may have began by combustion caused by the careless dumping of hot ashes on the culm bank during disposal operations. Fire origins generally are shrouded in an uncertain history (see table). The underground fire at Glen Lyon probably was started by an electrical wire which was knocked down during a wreck and subsequently ignited seven trolley cars of dynamite. The origin of both the Williamstown and Forestville fires is still uncertain. Extensive damage and considerable danger are generated by the fires. Because the fires are very difficult to control, they consume vast amounts of coal over the 20 or more years that they have been burning (see table). Many of the fires are not detected until years after their start (airborne infra-red photographs now are used for detection) and by this time, stopping them is almost an impossibility. The results can be quite devastating as the burned-out underlying coal seam may cause subsidence of the land surface destroying buildings and in general creating an eyesore over the whole area. The gases emitted by the burning materials can be very dangerous if ingested in great amounts (e.g., arsenic, selenium, sulfur, chlorine). Some of the gases such as hydrogen sulfide, sulfur dioxide, sulfur fumes, and carbon monoxide are polluting the air to such extents that visibility is reduced to virtually nothing. People who live near the coal fires suffer from various respiratory diseases and many have to be hospitalized. Water supplies may become polluted, paint discolors and peels, and cement construction crumbles more rapidly as a result of these fires and their resultant fumes. It is no wonder that the Commonwealth considers them a hazard.

Why all the concern from the Pennsylvania Geologic Survey? Recently new minerals were discovered at four mine fire sites (Williamstown, Glen Lyon, Shenandoah, and Forestville, Pennsylvania) which previously have not been found in the state, some nowhere else in the world. These discoveries led to an in-depth probe of the fires to find out what rare and harmful elements occur in the coal. For example, this may enable com-

Burning coal mine at Laurel Run

Location	**Dates of Fire***	**Possible Causes**
Glen Lyon		
Culm Bank	1932 - present	a) Spontaneous combustion b) Careless spread of hot ashes during normal refuse operations c) Burning of trash d) Spread of original culm fires to other areas
Underground	1956 - present	a) Electrical spark igniting dynamite
Shenandoah	1956 - present	a) Burning timbers fell down shaft b) Deliberately throwing in a hot stove in protest of bootlegging curtailment c) Children playing with fire near the mine
Forestville	1953 - present?	a) Burning of trash b) Obtain "red dog" c) Spontaneous combustion
Williamstown	1930's - present	a) Spontaneous combustion b) Spread of other culm fires c) Burning of trash d) Brush fires

* These are approximate dates

panies utilizing coal in the future to filter these minerals and elements out of the smoke emitted by power plants. Additionally, soluable compounds such as halides, sulfates, and native elements that are potentially dangerous even after extinguishment of the fires are being identified so that steps can be taken to eliminate any harmful effects.

Scarlift, a state agency program in the Department of Environmental Resources, presently is extinguishing the culm fires. Water from abandoned coal mines is being used to put out the fires, in some necessitating water dams or troughs to prevent flooding. The extinguished coal is then to be dumped as fill. These operations are state-funded by bonds used to temporarily purchase the fire areas and to extinguish the fires.

Linda Main
Edinboro State College

NATURE TO PRODUCE CHRISTMAS SPECTACULAR

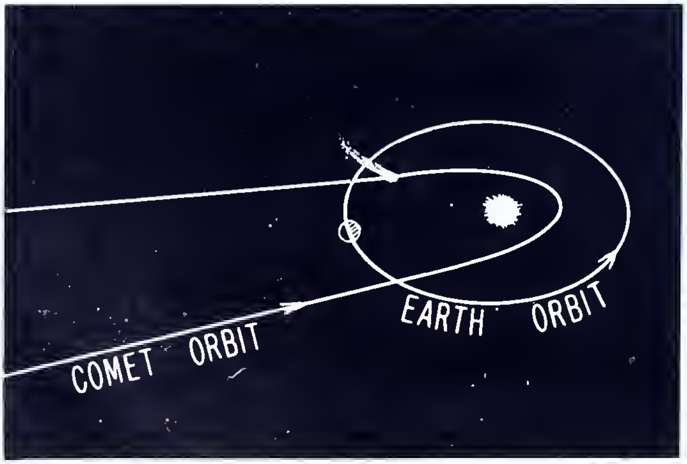
A spectacular visitor from outer space known as Comet Kohoutek 1973f should begin to show itself about mid November and achieve its most dramatic display during early January.

The comet was discovered in March of this year when it was more than 4 astronomical units (600 million km.) from the Sun. Louis Kohoutek of the Hamburg Observatory is the discoverer. The official designation of "Comet Kohoutek 1973f" indicates that it is the sixth comet to be discovered in 1973 and distinguishes it from Comet Kohoutek 1973e which was discovered by the same astronomer in February.

Some astronomers do not agree on the estimated brightness of the Comet and reports vary from a maximum predicted brightness of minus 10, second only to the Sun and full moon, to a minimum brightness of magnitude—4 which approximates that of the planet Venus. In either case it will be a dramatic sight, particularly in the evening sky at dusk a few days after perihelion, which places the time at early January.

During mid November Comet Kohoutek will be visible in the East shortly before sunrise and may require the use of binoculars or a small telescope to be seen well. During December the comet may be visible in the southern sky during the day if the brighter estimate of its luminosity is correct. During daylight it might be necessary to screen the Sun with an outstretched hand to observe the comet. Perihelion will be attained on or about December 28th at which time Kohoutek will be 21 million km., or only 30 solar radii, from the Sun. After this point the comet will become an evening object in the southwestern sky after sunset.

Extreme care must be taken if daylight observations are attempted for damage to the eye could easily result from staring into the Sun. In no case should binoculars or telescopes be used for daylight observation as retinal damage is sure to occur if the Sun is viewed through these optical devices.



January will be the best time to observe the comet tail in its full glory. In the evening twilight, a few days after New Year's Day, estimates of the length of the tail range from 20 degrees to 30 degrees across the sky which is about 10 to 15 full moon diameters. During this time amateures with adjustable cameras and fast films can obtain the most spectacular pictures.

Science teachers, students, and interested amateures should consult with the following references for additional information:

1) "Comet Kohoutek - Prospects and Plans," Sky & Telescopes, Aug. 1973.
2) "A Great Comet Coming . . . Kohoutek", Astronautics and Aeronautics, Oct. 1973.
3) "Get Set For the Sky Spectacular of the Century", Popular Science, Nov. 1973.

William H. Bolles
Department of Education

FROM BACTERIA TO POLLUTION-FREE ORE?

The present mining system for obtaining sulfide ores of copper, lead, zinc, molybdenum and other metals can be a dirty business. For example, smelters are coming under increasing pressure from environmentalists to reduce their air pollution arising from toxic trace elements and oxidized sulfur compounds. As a result, a new science has sprung up: biogenic metallurgy and chemical leaching. Reactions using certain microorganisms utilize inorganic matter and oxygen. Thus, certain bacilli are associated with the leaching of copper from copper sulfide ore minerals, producing water-soluble copper sulfate. Recently, colonies of microorganisms on molybdenite also have been identified (Brierly, Brierly, and Muir, Research and Development, Aug. 1973, p. 24-28).

Although study of the possibility of utilizing microorganisms to concentrate ore elements is just beginning, application to ore and waste piles as well as to below-surface ore bodies is intriguing. Also interesting is the fact that lower-grade rock could be processed than now is economically feasible, an important consideration as today's high-grade resources dwindle. Finally, this chemical leaching method that utilizes microorganisms does not pollute the air, certainly a point in its favor in any technological society.

Although there presently are many unknowns, such as which organisms react with a particular ore and the mechanisms of concentration, study is progressing, but rather slowly. Recognition of the help these little fellows may give us could stimulate needed research in this new field.

SURVEY ANNOUNCEMENTS

CLAY AND SHALE RESOURCES IN THE GREATER PITTSBURGH REGION — ON OPEN FILE

The Bureau of Topographic and Geologic Survey, Department of Environmental Resources, in cooperation with the U. S. Geological Survey and the U. S. Bureau of Mines, is continuing a multi-phase clay-shale program under the Greater Pittsburgh Regional Studies Program.

Phase II, now complete, involved the collection of 162 samples throughout the region from each major clay or shale geologic unit represented.

Phase III, the clay-shale sample test data, is now being released to open file. Evaluation for potential uses are reported for the 162 clay-shale samples. These evaluations are based upon the results of firing tests and determinations of other critical properties. Data presented in the report include: 1) test results for raw properties, slow-firing and preliminary bloating, 2) emission spectrographic analyses, and 3) rapid rock analyses. The site of each sample is plotted on a location map of the region.

Phase III is now on open file at three locations: Bureau of Topographic & Geologic Survey, Room 419, Town House Apartments, Harrisburg; the Survey's Regional Office at 1201 Kossman Bldg., Stanwix Street, Pittsburgh; and the U. S. Geological Survey, 102 East Mall (Second Floor), Carnegie. All interested persons are encouraged to examine this report at any of these locations.

CONSTRUCTION AGGREGATES IN THE GREATER PITTSBURGH REGION OF PENNSYLVANIA — OPEN FILE REPORT

The Bureau of Topographic & Geologic Survey, Department of Environmental Resources, in cooperation with the U. S. Geological Survey, has released to open file a detailed report concerning sources of construction aggregates in the Greater Pittsburgh region. Active producers of sand and gravel, crushed stone, and slag — the present source of aggregate in the area — are identified and information on the geologic formation, physical test results, and current uses of aggregate from each operation is summarized.

Eight geological subdivisions with a potential for sand and gravel are plotted and discussed by origin, relative age, lithology, thickness, extent of weathering, and evaluated for construction aggregate. Areas where residential, industrial and/or recreational land-use conflicts exist are screened out.

The outcrop patterns for the Loyalhanna Formation and the Vanport Limestone — two important sources of crushed stone in the region — are plotted and isopachs showing the thickness of the Vanport are shown. Six other geological units supplying crushed stone and the availability of slags are also discussed. An evaluation of the potential for each unit is made.

This report is on open file at three locations: Bureau of Topographic & Geologic Survey, Room 419, Town House Apartments, Harrisburg; the Survey's Regional Office at 1201 Kossman Bldg., Stanwix Street, Pittsburgh; and the U. S. Geological Survey, 102 East Mall (Second Floor), Carnegie. All interested persons are encouraged to examine this report at any of these offices.

STUDENT INTERN AT THE SURVEY

Linda Main, a junior geology major at Edinboro State College, joined the Survey staff on September 10 to be with us for 16 weeks as an Intern, one of many such students working in various positions in State Government.

Linda is a resident of New Castle and graduated from New Castle High School in 1971. She is studying for her Bachelor of Science degree at Edinboro and hopes to go to graduate school to major in geophysics and seismology. Linda is an outstanding student at Edinboro and received the 1972 chemistry award for the outstanding chemistry student at Edinboro.

While at the Survey, Linda will learn how a Survey operates and functions. She is engaged in several short-term research projects dealing with minerals from burning coal mines, analysis of glacial sands and gravels in northeastern Pennsylvania and preparation of isopach maps for hydrologic investigations.

The Student Intern Program operates in cooperation with the Department of Education and is aimed at giving students practical experience in their chosen field of work.

EARTH SCIENCE TEACHERS' CORNER

usgs popular geology leaflet series

Several new U.S.G.S. leaflets have been published.

"THREE RINGS: TIMEKEEPERS OF THE PAST", 15 pages

Botanists and hydrologists have found that trees are nature's timekeepers and historians, providing windows to the past; U.S.G.S. Water Resources Division has been conducting basic research to determine what hydrologic and environmental information is revealed in the growth records of trees.

"The NATIONAL ATLAS STORY", 15 pages

This atlas makes available for the first time in one volume a comprehensive source of information, presented in cartographic format, about the principal characteristics of this Nation; basic details on the Atlas and an order blank are included in this leaflet.

"WATER IN GREAT SMOKY MOUNTAINS NATIONAL PARK", 14 pages

This leaflet describes the role of water in carving the natural beauty of the park, the abundance of water available, the use of water, the early settlers of the region, and the destructive side of water in flood and erosion.

"GEYSERS", 23 pages

The answers to the following questions are given in this leaflet: What is a geyser? Where do geysers occur? What causes hot springs? How are geysers born and why do they die?

These pamphlets and many others are available free of charge from the U.S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia 22202.

SUSQUEHANNA WATER GAPS — NATIONAL NATURAL LANDMARK

The area of five water gaps along the Susquehanna River, north of Harrisburg was dedicated on September 4, 1969 as a Registered Natural Landmark. Since that time, the number of visitors that have come to admire the magnificent scenery of the water gaps along this section of the river has surely increased.

The State Geologist, Arthur A. Socolow, was a featured speaker at the dedication of a bronze plaque commerating this outstanding natural landmark. His remarks that day traced the history of geologic events which produced the water gaps.

Now, still another event has taken place. The bronze plaque attached to a massive piece of conglomerate was originally placed at the foot of an observation tower along U.S. Route 22-322 between Dauphin and Clarks Ferry. Recently, this land changed ownership and the bronze plaque and stone marker were moved to the very picturesque roadside rest at Girty's Notch along U.S. Route 11-15 between Amity Hall and Liverpool. We heartly recommend taking a few moments of your time to stop to visit.

Alan R. Geyer

MULTI-COLORED FLUORITE AT NEW PARIS

Beautifully colored cleavages of purple, aqua-blue, and yellow-green fluorite (CaF_2), along with a few cubic crystals were collected from the New Paris Lime and Stone Company quarry, approximately 1 mile north-northeast of New Paris in Bedford County. The fluorite, intergrown with white calcite, is restricted to a few, nearly vertical veins up to three inches wide. This may represent the largest single occurrence of fluorite reported from the state; certainly it is one of the most colorful.

The main fluorite vein trends N 14° E, 80° SE and is almost perpendicular to bedding. This vein, along with calcite veins containing smaller amounts of fluorite, as well as unmineralized joints, are all parallel to a pronounced set of joints cross-cutting bedding and trending N 12° E, 88° SE across the quarry. The quarry itself is located on the northwest limb of a gentle anticline and bedding is dipping uniformly to the northwest (N 39° E, 7° NW). The operation is recovering limestone from the Keyser Formation of lower Devonian age and is presently quarrying in the upper part of this formation.

There is no sign of host rock replacement along the largest exposed fluorite vein. This fact and the lack of a paleokarst topography (ancient erosion surface on limestone and associated caves which were buried and preserved in the geologic record) suggest that no large voids developed for later infilling by fluorite, and therefore there is no economic potential for this occurrence as a fluorspar deposit. This fluorite does substantiate widespread, low-temperature hydrothermal activity (not necessarily of magmatic origin) along the Allegheny Front. The temperature of fluorite formation can be determined from the homogenization temperature of the fluid inclusions. Samples were collected for this purpose and are available for analyses. Such a study would be useful in determining possible relationships among fluorite, barite, sphalerite and galena, and the hydrothermal history of the area.

Mr. Pen Ambler of Hollidaysburg brought this locality to our attention. It is through help such as his that we can better understand the geology of the Commonwealth.

Robert C. Smith II
John H. Way, Jr.

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In Cooperation with The U.S. Geological Survey

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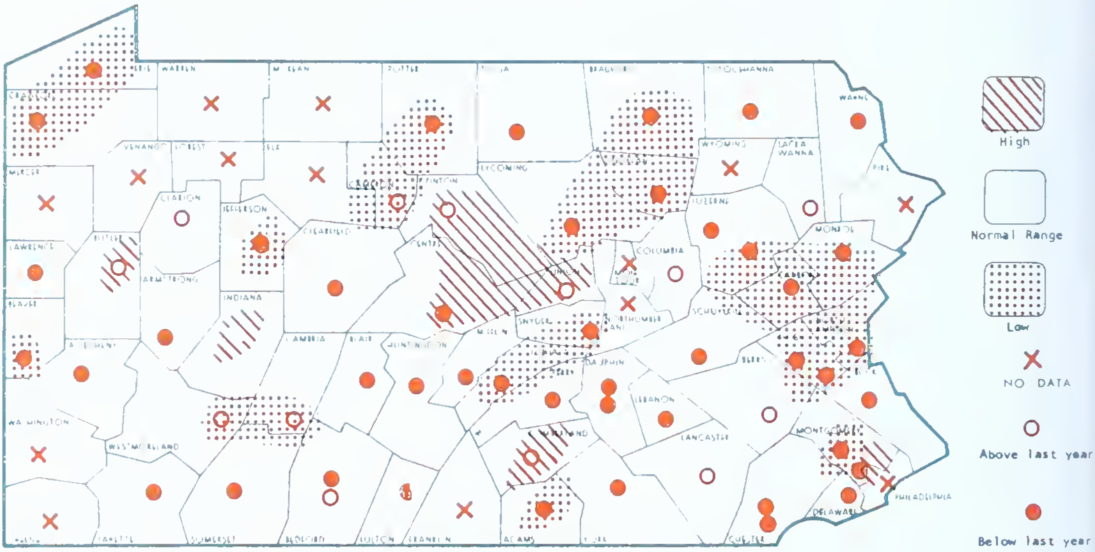
In Cooperation with The U.S. Geological Survey

NOVEMBER 1973

GROUND-WATER LEVELS



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